A QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

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The SCIENCE COUNSELOR

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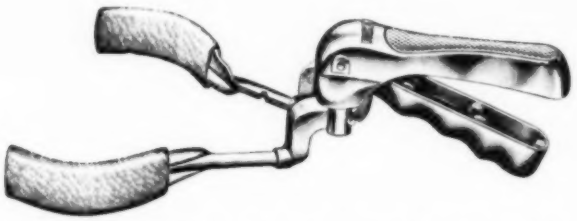

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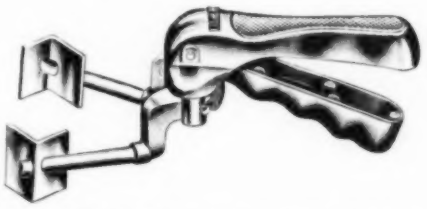

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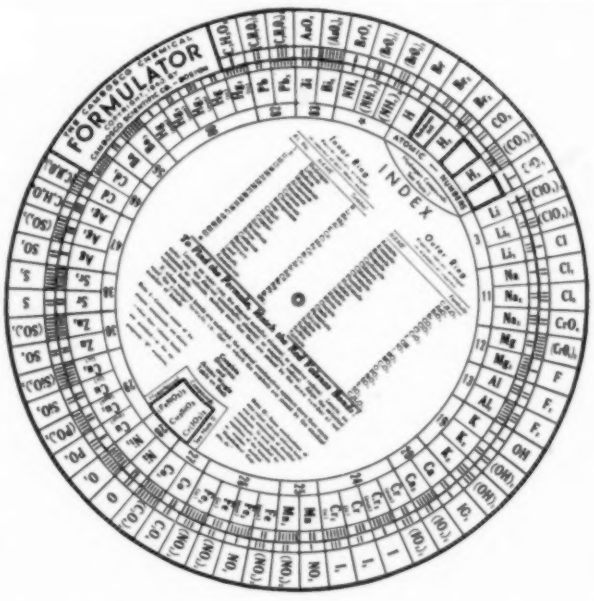

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Oxygen and Industry

• **By Earl P. Stevenson, M.S.** *(Massachusetts Institute of Technology)*
PRESIDENT, ARTHUR D. LITTLE, INC., CHEMISTS, ENGINEERS, CAMBRIDGE, MASSACHUSETTS

As a result of recent research, oxygen is now being extracted from the atmosphere in such tremendous quantities and at such low cost that many new applications in industry have been found for it.

This up-to-the-minute account discusses the new production techniques and the large-tonnage uses that have been developed for oxygen in the steel, fuel gas, synthetic gasoline, and other industries.

Every teacher of chemistry needs this information.

●

Oxygen of high purity has been available for industrial use only since 1900, when Carl von Linde applied the process of rectification to liquid air. Many advances in the art of separating oxygen from the atmosphere have resulted in recent years from a wartime development program for all branches of the armed services. Most of this wartime development was directed toward generation of oxygen in small units in the field, since the conventional methods of shipping oxygen in high-pressure cylinders or tanks were impractical for some wartime demands.

As a result of recent research, oxygen can now be made in tremendous quantities at a lower cost than was previously possible, and can also, where desired, be made on a smaller scale than before. From a technical standpoint, the new developments include the low-pressure cycle based on use of reversing heat exchangers, and improvements in the efficiency of expansion engines by means of which the cold, compressed air gives up enough energy so that most of it liquefies.

The reversing heat exchanger consists essentially of three concentric tubes. Pure gaseous oxygen flows continuously from the center tube, while compressed air and waste nitrogen at atmospheric pressure flow alternately through each of the two annular channels. An important feature of the reversing heat exchanger is that, in addition to cooling the incoming air, it purifies the air by freezing out minor condensable fractions such as water and carbon dioxide, along with traces of hydrocarbons derived from lubricants used in the system. As the air cools, the impurities are deposited on the walls of the channel. After a few minutes of such deposition the air is switched to the second channel, and large volumes of nitrogen are sent through the first channel, evaporating the impurities and carrying them out to the atmosphere, thus preventing plugging of the channel. The conventional method of purification has been by chemical means, in separate equipment.

The reversing heat exchanger transfers heat from the incoming compressed air to the cold outgoing oxygen and nitrogen so effectively that air can be liquefied after compression to only 75 to 100 p.s.i. The possibility of operation at this low pressure permits the use of less costly equipment in a greatly simplified process.

The cold compressed air is expanded through the expansion engine to achieve liquefaction, just as the refrigerant is expanded through a valve in the household refrigerator. Improvements in these engines now permit efficiencies as high as 85 per cent for small reciprocating engines. Similar improvements were made in turbo-expanders for large liquefiers. These improvements substantially reduce the cost of oxygen production.

During World War II, there was almost a threefold increase in the industrial use of high-purity (99.5 per cent) oxygen. According to recently published estimates by the Linde Air Products Company, the use of oxygen today is roughly divided thus: steel industry, 40 per cent; steel fabrication, 25 per cent; industrial maintenance, 8 per cent; other miscellaneous uses, including breathing oxygen, automotive and aircraft, chemicals and petroleum, and scrap iron, 27 per cent.

Until the late '30's, shipment of oxygen was entirely in steel cylinders at 2000 pounds pressure. More recently, truck trailers have been used to carry multiple high-pressure vessels, and specially insulated tank cars carry liquid oxygen at substantially atmospheric pressure. The liquid oxygen is then vaporized in autoclaves at the consuming point to deliver gas to high-pressure storage. In some cases, oxygen-producing plants have been built to deliver gas by pipeline to large consumers.

Since the new production techniques make relatively small and inexpensive installations possible, it is expected that some consumers using oxygen for purposes now well-established may operate their own small plants to produce about 1000 to 2000 cubic feet of oxygen per hour, thus avoiding the expense of transporting the oxygen. A low-pressure cycle employing reversing exchangers possesses a number of advantages for small-scale operation, since the units can be made largely automatic.

Quality of oxygen is not the issue in choosing between purchased and consumer-produced oxygen. Although German low-pressure units cannot produce

(Continued on Page 131)

Chromatography

A Method of Separating Mixtures of Substances

• **By Harold G. Cassidy, Ph.D.** *(Yale University)*
ASSISTANT PROFESSOR OF CHEMISTRY, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT

One of the less familiar methods of separating the components of mixtures has increased in importance in recent years until it has become one of the very important research tools of the analytical chemist. Teachers of science should know about this method and understand how it operates.

Before discussing the process itself, Dr. Cassidy gives a brief but clear explanation of adsorption, the phenomenon which forms the basis of the method.

The several demonstration experiments here described should tempt many readers to try out the method.

●

Nature is a colossal mixture, and most people spend a good part of their lives sorting out, distinguishing between, and looking for regularities in, various aspects of Nature. Everyone makes separations: if one could not separate dimes from pennies he couldn't make change. Everyone makes distinctions: if one couldn't distinguish dimes from pennies he couldn't separate them. Distinctions and separations are part of the same problem. In order to distinguish between the components of a mixture one has to show that they can be separated. Separations are usually made to simplify some problem. It is easier to deal with things of the same kind separately than in a mixture, and this is why people who have to make change frequently usually keep pennies in a separate compartment from dimes. The simplifications which can be brought about by making separations and distinctions are necessary in looking for regularities in Nature, which is one of the occupations of scientists in all fields.

The problem of making separations is particularly important in chemistry. Here separations have to be made at the molecular level, and since no one has ever seen a molecule, special techniques have to be used for sorting them. There are a great many techniques available for sorting molecules. A number of them operate on the same fundamental principles, and perhaps through a discussion of chromatography some of these principles may be brought out. In this way the discussion would have a greater value than the discussion of a single isolated method might have. This would be an example of finding regularities or resemblances between different methods.

Chromatography is a method of separating chemical substances by means of adsorption. It was invented by Mikhail Tswett in 1906, and is sometimes called Tswett adsorption analysis. Tswett was interested in separating the green and yellow pigments which can be extracted from leaves, and he found that the separation could be accomplished by using adsorption in a special way. His method can be applied to all sorts of mixtures and has become one of the most important research tools of the analytical chemist. Tswett's method will be described below, but first a word has to be said about adsorption.

Adsorption is a phenomenon which occurs at surfaces. To a chemist, a surface is a region in which one kind of molecule gives way to another kind, or one substance to another. There is a definite transition in properties at a surface, and it is, indeed, this transition which marks the surface. Water in a drinking-glass, for example, has two different kinds of surfaces, an air, water surface and a glass, water surface. At the air, water surface (or *interface* as it is commonly called) the surface water molecules attract each other and the molecules below them but have little effect on the widely spaced molecules of the air above. This non-uniform attraction causes a surface tension to exist; there is a strong inward pull on the surface molecules which tends to keep the surface area as small as possible (this is shown by the fact that falling drops tend to take a spherical shape).

An analogous interfacial tension exists at the glass, water interface. If an adsorbable substance is put into the water it is observed that the surface tension decreases at the interfaces, and further examination shows that molecules of the substance have congregated in the interfaces. These molecules are said to be *adsorbed at the surfaces.* They lower the interfacial tensions by making less sharp the transitions between the phases. Adsorbents are substances which are either very porous or very finely divided, so that they have a large surface area for a given weight.

Substances differ in the extent to which they are adsorbed from a given solvent and on to a given adsorbent. Some substances are strongly, others weakly, adsorbed. If an adsorbent is put into a solution containing equal amounts of two such substances (see Figure 1 for a diagrammatic representation of this) the more strongly adsorbed substance, represented by the black dots in the Figure, will be taken up by the adsorbent to a greater extent than the more weakly adsorbed one. The concentration of the solution will therefore be changed, and if the adsorbent is now filtered off a partial separation of the two substances will be found to have

been achieved. The more strongly adsorbed substance can be recovered from the adsorbent by displacing it with a still more strongly adsorbed one, and the resulting product will have only a little of the less strongly adsorbed substance in it. This latter will be found in the filtrate. Such a separation is never perfect because some of each kind of molecules are always adsorbed and some are left in solution.

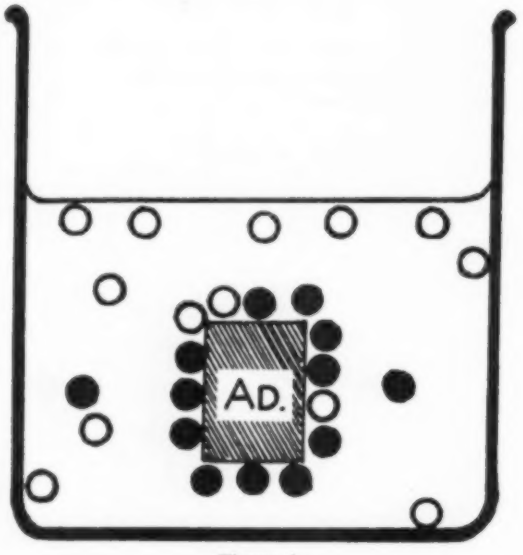

Figure 1

FIGURE 1. Adsorption. Black Dots, Molecules of Substance A; Open Dots, Molecules of Substance B. Ad. is the Adsorbent.

Adsorption used in this way is of little value in separating mixtures containing very many different kinds of molecules, but it is described because certain features are of importance to a discussion of Tswett's method. In the *first* place, the adsorption process is a reversible one. Molecules are able to move into and out of the interface. They are adsorbed because they move in more easily than they move out; because the residual attractive forces of the surface molecules of the adsorbent tend to keep them in the interface. The fact that adsorption is reversible means that the extent of removal of molecules from a solution can be influenced in either direction. That is, with a given amount of solution addition of more adsorbent removes more molecules by adsorption. Conversely, if the concentration of the solution were decreased by the addition of pure solvent, molecules would be desorbed. This relationship is implied in the equilibrium statement:

Molecules in solution $\rightleftharpoons$ Molecules in interface

In the *second* place different molecules are adsorbed to different degrees. The surface can hold on to some kinds of molecules more strongly than to others.

Apart from its importance to the Tswett method there is another reason for the discussion of the adsorption process. Adsorption is the result of a partition. Molecules distribute themselves between a solution phase and an interfacial phase, and are said to be adsorbed when their concentration in the interfacial phase is greater than it is in the solution phase in contact with the interface. Many other distribution processes are known, and these differ from each other in the kinds of phases between which the partitions occur. In the boiling of a mixture a partition occurs between a liquid phase and a gaseous phase; the more volatile component concentrating in the gaseous phase. The separation process of distillation is based on this partition. In liquid-liquid extraction the partition is between two nearly immiscible liquids, and a separation process is based on this. In crystallization the partition is between a solution and a solid phase. The separation here is a crystallization process. In chromatography, adsorption is used as the partition process, but it is used in a special way the discussion of which will have to await a description of chromatography.

In the chromatographic method the adsorbent is packed into a tube, so that it forms a *column* (see Figure 2 for a diagrammatic representation of this process for a mixture of two substances A and B). The mixture to be separated, a solution of A and B in some solvent, is allowed to flow into this column. As the solution passes over the adsorbent the mixed solutes are removed by adsorption, and the solution becomes diluter. The diluter solution continues to flow down the column, continually coming into contact with fresh adsorbent, and losing solute by adsorption, until *all* solute is finally removed. This is shown in Figure 2b. At this point the solute is all adsorbed in a *mixed zone* at the top of the column, and the pure solvent has passed on and wetted some of the adsorbent below the zone. If pure solvent or some other liquid is put into the tube above the column and passed into the adsorbent it will at first pick up some A and B because it was 'empty' and the adsorption is reversible. It will desorb as much of the solutes as is permitted by their degrees of adsorbability. More of the less well adsorbed B will be picked up by the solvent than of the more strongly adsorbed A, and some A will be deposited in the places from which B has been removed. The solution thus formed, flowing on down the column, eventually comes to the foot of the zone and there meets fresh 'empty' adsorbent. Adsorption then occurs and the solutes are re-deposited.

Two important things have taken place in this step: the pure liquid (called a *developer*) which was passed into the column picked up material at the top of the zone, transported it downward, and deposited it at the foot of the zone; also, since in the process it picked up relatively more B than A, a certain degree of sorting occurred, B being moved downward further than A. As the passage of developer is continued B will gradually draw away from A until eventually, as shown in the Figure 2d the two will have formed zones quite separate from each other. The *chromatogram* is said then to be *developed.*

At this point one of two steps may be taken. Either the washing can be continued until each zone is separately washed out of the column and collected, or else the entire column of adsorbent may be drained of solvent, extruded from the tube, and cut apart between

the zones. Each substance may then be recovered separately by putting the part of the column containing the zone into a tube and passing a desorbing solution (an *eluent*) through it. A description of several experiments will make this more clear.

An experiment very similar to one of those performed by Tswett can be done as follows. The substances to be separated are leaf pigments. Pick a small amount of fresh grass (a carrot leaf may be used), tear or cut it up and rub it in a mortar with a few ml. of alcohol mixed with about twice the amount of petroleum ether until the solvent mixture becomes quite green with the leaf pigments. The alcohol (acetone may be used instead) is necessary to help extract the pigments, but it must be completely removed from the green extract before adsorption. This is done by washing the extract thoroughly with water, whereupon the leaf pigments go into the petroleum ether layer which can be separated off from the water layer. The petroleum ether layer must then be dried by swirling it in a flask with a little anhydrous sodium sulfate. If all the materials are on hand this whole operation, from green grass growing to dry green extract, should take less than an hour.

While the pigment extract is drying a column of adsorbent is prepared as follows: Take a medicine dropper or a piece of 7mm. glass tubing drawn out like a medicine dropper and place a small wad of cotton in the constriction. (The rubber bulb is removed, of course.) Put into the tube above the cotton some calcium carbonate U.S.P. (precipitated chalk) and press it down gently with a thin rod (an applicator stick is a little too thin, perhaps). Continue adding adsorbent and pressing it down evenly until a column about 2½ to 4 cm. long has been formed. Confectioners powdered sugar may be used instead of calcium carbonate. Now drip a little of the dried petroleum ether leaf-extract into the tube above the column and let it run into the adsorbent evenly. A green zone will form, and enough of the extract should be used to give a zone 3 to 4 mm. deep. If the petroleum ether solution is not free from alcohol (not washed enough), or if it is wet (not dried enough) the zone will not form, but the green solution will pass on through the column. The mixed zone can now be developed into a chromatogram. If the adsorbent is calcium carbonate, use benzene as the developer; if it is sugar, use petroleum ether containing one-fourth to one-third part of benzene.

The development takes only a few minutes. As the developer liquid passes into the column the green zone spreads out and becomes differentiated into an upper thin dark-green zone, a lower wider blue-green zone, an orange zone below this, and at the bottom a very fast-moving, hard-to-see, yellow zone. The upper green zone is chlorophyll *b*, the lower blue-green zone is chlorophyll *a*, the orange zone contains a mixture of xanthophylls, and the yellow zone of carotenes. When development is complete the column is allowed to drain, and is extruded from the tube as a cylinder. This is sectioned between the zones and each pigment eluted separately by washing its zone with petroleum ether (or benzene) containing a drop of alcohol. The fast-moving yellow and orange zones may be washed out before the column is extruded. The separation of the mixtures of carotenes and of xanthophylls requires more subtle chromatography such as is described in books which deal with this subject.[1]

Chromatography can be applied to inorganic substances and to colorless substances of all kinds, but special methods which are beyond the scope of this brief article have to be used. The methods are described in the books referred to above, and in review articles.[2]

If the solvents and techniques of the above experiment are not available a chromatogram may be produced in the following way. Prepare a column of chalk as described above and add a few drops of water to it. Before all of the water passes into the adsorbent add a drop or so of Shaeffer's V-Black Skrip ink.* As this passes into the column it gives a fine black zone. Develop this with water. A brilliant chromatogram is formed as the pigment mixture of the ink is separated. A purple-red zone appears at the top of the column, a blue-green one below this and a narrow yellow zone lower down. Other inks may be examined in this way. Some contain single pigments, others mixtures, depending on the purpose of the ink. If two colors of ink are mixed together they may sometimes be separated on the column to give a striking chromatogram.

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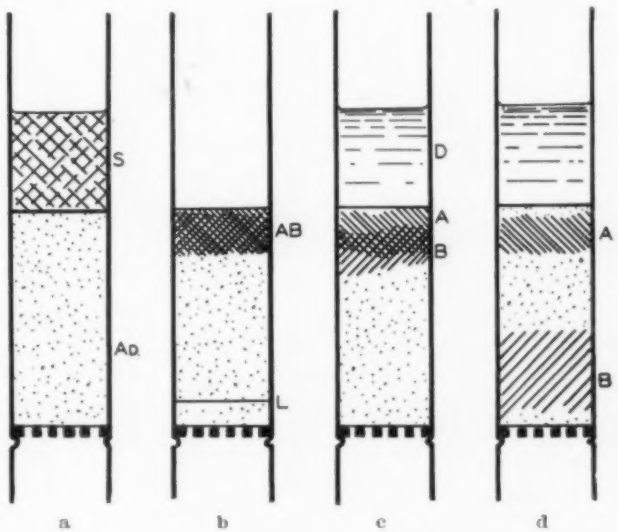

Figure 2

FIGURE 2. Chromatography of a mixture of Two Solutes A and B. *a*, The Solution Containing A and B is placed above the Adsorbent Ad.; *b*, The Solution Has Been Pressed Into the Adsorbent, a Mixed Zone AB is Formed, and the "Front" of Pure Liquid is Shown at L; *c*, Developer Liquid D is Being Passed Into the Column and Development of the Zones is Beginning; *d*, Continued Passage of Developer Liquid has Produced a Developed Chromatogram, with the Separate Zones Shown at A and B.

*The use of this ink was first suggested to me over a year ago by Dr. John D. Gregory.

Mathematics—Natural Science, Liberal Art

• **By Sister M. Claudia, Ph.D.** *(University of Michigan)*
CHAIRMAN, DEPARTMENT OF MATHEMATICS AND PHYSICS, COLLEGE OF ST. FRANCIS, JOLIET, ILLINOIS

What position does natural science occupy in the hierarchy of science? Is it one of the chief branches of liberal arts? What of mathematics? Is it a "mixed science?" What are its methods? Is mathematics worthy of the high place that has long been assigned to it?

These points as well as a number of others are discussed in this paper which was presented at a recent faculty meeting at the College of St. Francis.

●

In most liberal arts colleges the division of natural science comprises not only the departments of biology, chemistry, physics and astronomy, but also mathematics. This paper is an attempt to ascertain the role of the division of natural science in the liberal arts college, and the aims of this division in the curriculum of such a college. It will attempt to show that mathematics in fulfilling the mixed role of an art and a science has aims that are in harmony with those of the division of natural science.

Natural Science in the Hierarchy of Science

The word science, in general, embraces two great dominions, that of wisdom, which knows things by first causes and the highest reasons of being, and that of science which knows things only by secondary causes.[1] The two broad divisions of science are deductive and inductive. A deductive science is a science of explanation, an inductive science is a science of observation.[2]

The three supreme sciences according to Aristotle and St. Thomas are in the ascending order, *physics, mathematics* and *metaphysics*. We will approach this hierarchy of science by showing the relations among them, particularly the relations based on intellectual dependence.

The three supreme sciences are founded on different degrees of abstraction. Regarding the first degree, the mind limits itself to the consideration of material things and their properties which are *experimentally observed*. This is the science of physics. (Here physics is to be understood in the medieval sense, namely, a *sort of* natural philosophy.) The second degree of abstraction, the science of mathematics, pertains only to quantity, number, and extent, quite apart from their sensible manifestation in material things. Metaphysics, the third degree of abstraction, is the science which concerns itself with *being* as *being*.[3]

Although specifically different, physics and metaphysics have this in common, that they deal only with intelligible objects which *can* exist,—that is, objects which have hot only actual existence but possible existence outside the mind. Mathematics, on the contrary, deals with objects which are not necessarily real, but which can just as well be imaginary.[4]

The natural sciences (here we are excluding mathematics) belong to the first degree of abstraction. So closely are they related to the philosophy of nature that the latter would cease to exist if the experimental sciences were taken away. The more perfect the empiric sciences are in their facts, the more perfect will be the search for their causes.[5]

However, the experimental sciences are dependent upon philosophy as regards their principles. Facts as facts do not constitute scientific knowledge. Phenomena must be correlated. This can be done according to certain laws of the mind, and the laws of the mind are the laws of philosophy.[6]

A science with a more universal object and principle may apply its principles to a lower science. But a science with a more restricted object may not apply its principles to a higher science. Thus, mathematics may be applied to physics and we have mathematical physics. Metaphysics applied to mathematics gives mathematical logic; applied to experimental data it produces cosmology or the philosophy of inanimate being; and applied to biology it results in a philosophy of animate being or psychology.

Hence we conclude that the division of natural science occupies in the hierarchy of science not only an important but a vital position, for science is the daughter of truth. "Nothing can be more certain than all her findings. . . . Science supplies the data, philosophy applies to them her immutable principles."[7] But science and mathematics go helplessly astray when they venture "into the alien realm of metaphysics, declaring that nothing exists except what can be made by them empirically evident and measurable, when rashly they assume to pronounce on morality and God."[8]

The Division of Natural Science in the Liberal Arts College

The ideal of liberal education is, according to Professor Keyser, not mere efficiency but *intelligence, emancipation,* and *magnanimity*.[9]

Intelligence is the ability to comprehend the meaning of a science or an art, that is the ability to comprehend the specific truth or beauty that it offers. The objective of education is to see that the students grasp this truth or beauty by the natural intuitive energy of their reason supported by their whole sensuous, imaginative, and

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for DECEMBER, 1947

Sugar as an Industrial Chemical

• **By Robert C. Hockett, Ph.D.** *(Ohio State University)*
SCIENTIFIC DIRECTOR, SUGAR RESEARCH FOUNDATION, INC., NEW YORK CITY

To persons who are accustomed to think of sugar only as a sweetening agent and food this paper will be an eye-opener, for sucrose is the source of many chemical products. Thousands of derivatives have been made from it by biological and chemical processes.

This account, written by an outstanding expert, can do no more than suggest the wide variety of products now made from sugar that the modern world finds useful. It points the way to further research and study.

●

Almost 10,000 sugar derivatives have been described by scientists. Of these probably at least half can be made directly or indirectly from the common sugar sucrose. Those which can be made available directly from sugar or molasses at low cost number in the hundreds. Industrial chemical history abounds with evidence that compounds which can be made available in quantity and distributed widely for test and experimentation will find applications sooner or later. There are grounds for believing that this history may be repeated in the case of sugar derivatives.

To explore these possibilities Sugar Research Foundation has been charting the behavior of the sucrose molecule at its Massachusetts Institute of Technology laboratory and sponsoring half a dozen other projects to shed more light on the industrial value of sugar as a chemical.

The use of sugar as a food is so well known that industrial applications tend to be overshadowed. Nevertheless, if all food uses vanished overnight, it would still be necessary to class sugar as one of the most important industrial chemicals.

Some of the most important applications of sugar involve transformation products in which sugar is so profoundly altered that it is easily overlooked. The "chemists" who perform these alterations are the yeasts, molds and bacteria. Ordinary alcoholic fermentation has been known since prehistoric times, and still remains the most important biochemical transformation of sugar. Until the war, sugar, in the inexpensive form of molasses supplied almost 90 per cent of industrial alcohol, the most important organic solvent.

The older uses of alcohol in industry are so well known that they do not need to be repeated. The production of synthetic rubber, however, so increased the demand for alcohol beyond any previously experienced need that molasses supplies were insufficient and very considerable inroads had to be made into the supplies of food sugar. In 1943 about 70 per cent of all the synthetic rubber produced was made by the alcohol process.

Wholly chemical methods of transforming pure cheap sugar into valuable chemical compounds for industry are being sought at Massachusetts Institute of Technology.

New Industrial Uses

Alcoholic fermentation is not the only profound transformation of sugar performed by micro-organisms. Newer industrial outlets for sugar are also within the fermentation field. A notable example is the acetone-butanol fermentation. During World War I the Allies required considerable amounts of acetone for the production of airplane dopes and the explosive cordite. The traditional processes of hardwood distillation provided about 10,500,000 pounds, a new record for the time, but inadequate for war demands and of inferior quality. The firm of Strange & Graham, Ltd., found a bacillus which would produce acetone from potatoes but not from cereals. This process gave some relief but was soon replaced by the Weizmann fermentation involving another organism which effectively fermented corn mash. Plants were established at Toronto and Terre Haute to produce acetone near the sources of corn.

The end of World War I brought about a temporary slump in demand but new uses for both acetone and butanol soon revived the industry. Acetone proved useful in spinning cellulose acetate "silk." Later it became the basic material for producing the transparent "lucite" or methacrylate resins. Meanwhile, the use of corn mash was almost completely replaced by the cheaper material, molasses. By 1939, peacetime acetone production had become ten times as great as in the war year of 1914.

Acetone is used also as a solvent for acetylene gas compressed in cylinders for oxy-acetylene torches, in photographic films, in de-waxing lubricating oils and for the extraction of insulin. It is converted by chemical means into ketene, which in turn is used to produce the acetic anhydride necessary for making cellulose acetate. Thus acetone plays a double role in the rayon and film industries. Diacetone alcohol made from acetone is a popular hydraulic brake fluid. Mesityl oxide and methyl isobutyl ketone are very important solvents.

Butanol

Butanol, which constitutes the second major product of this acetone-butanol bacterial fermentation of sugar, made possible the nitrocellulose lacquer industry since butyl acetate proved to be an ideal solvent. It finds another use in a new woodpulping process. By dehydrogenation, butanol forms butanal which enters into the composition of the latest and best resin for safety glass. These polyvinyl butyral resins are also used to make substitute "rubber" tubing for which purpose they are plasticized with other butanol esters, dibutyl phthalate and sebacate. Cellulose acetate butyrate is an important plastic.

This chain of products, all produced from molasses and all dating from 1914, indicates the possibilities which exist in the exploitation of new fermentations.

Citric Acid

Another fermentation of sugar in which the active agent is a mold, produces citric acid identical with the citric acid of lemons. Citric acid is not only one of the most important acids of the food industry (finding extensive use in soft drinks and confectionery) but also plays a role in medicine. Citrate of magnesia is used as a laxative and iron citrate for anemia. More important, citric acid prevents coagulation of blood and is extensively used for that purpose in processing blood for plasma. Aconitic, citraconic and itaconic acids, all derivable from citric by chemical means, play a role in the plastics industry.

Still another mold produces gluconic acid, whose calcium salt is very widely used to supply calcium to persons suffering from a deficiency of this element in the blood. It is often administered intravenously in sterile solutions not only to human beings but to cows. In cases of "milk fever" in cows, two or three ounces may be injected into the jugular vein in a single dose.

The acidophilus bacteria convert sugar into lactic acid, identical with the acid of sour milk. This acid finds its greatest use in the tanning industry where it effectively removes the lime left by the dehairing process without damaging the hide. Lactic acid also finds use in dyeing wool and finishing textiles. The edible grades are being used increasingly in food products such as candies, beverages, infant foods, poultry feeds and stock feeds. More recently chemical transformation products of lactic acid have been reported. Ethyl lactate is an important solvent. The acrylates, produced by dehydration of lactic esters, are capable of polymerizing into plastic materials with a variety of properties which can be modified over a wide range.

Products Await Development

A great many other chemical products produced by yeasts, molds or bacteria have been recorded in scientific journals and await industrial exploitation. Fumaric acid, butylene glycol, keto-gluconic acid and biacetyl (which gives butter its characteristic flavor and is partly responsible for the improvement of margarine over that available twenty years ago) are other fermentation products in various stages of industrial development.

The production of yeast also employs molasses as a substrate. Yeast not only plays its traditional role as a leavener of baked goods (by acting upon sugar) but is now recognized as a food in its own right. Yeast is one of the richest sources of the B vitamin complex and supplies a protein of high biological value. The Army blended dried yeast into the soup powders of its field rations to assure an adequate supply of these nutrients.

Direct Chemical Transformations

Although fermentative transformations of sugar are prominent, some direct chemical conversions are used. The action of mineral acids upon sugar produces levulinic acid whose esters find some use in plastics as plasticizers. Calcium levulinate is used in much the same

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Synthetic Detergents and Surface Activity

• **By Cornelia T. Snell, Ph.D.** *(Columbia University)*
FOSTER D. SNELL, INC., CONSULTING CHEMISTS, NEW YORK CITY

More and more, synthetic detergents are replacing soap as a cleansing agent in the household as well as in industry. Some of these new laboratory products have marked antiseptic value.

What are these new cleaners; how do they operate; can they be used in hard water; what are their advantages and disadvantages; what have they to do with surface activity?

You will find answers to these and to many other questions in this valuable paper, written by an outstanding specialist in the field.

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Just as silk stockings have largely been replaced by nylon, so has soap been replaced for a number of uses by modern synthetic products, also the result of intensive chemical research. Although synthetic detergents, sometimes termed soapless soaps, first appeared back in the 1920's, many people did not realize their real significance until the war period, when soap was difficult to get here at home, and special soap-synthetic combinations had to be supplied in huge quantities to our Army and Navy to do a good cleaning job in all kinds of water and even in sea water. Producers of synthetics did their best to meet the emergency needs, so that we now have a synthetic detergent industry amounting to more than a half-million pounds a year.

Before taking up surface-activity in general and specific types of agents in particular, it would seem desirable to have an understanding of some of the principles involved in cleaning so as to see why some chemical compositions are better for the purpose than others.

Nature of Soil

Whether on the hands, clothing, table linen, dishes, walls, or floors, soil may be considered as much the same, differing in amount rather than in kind of materials present. It is a combination of water-soluble materials which can be easily rinsed away and therefore offer no real cleaning problem—with insoluble substances such as lint, dust, soot, some types of proteins and oily matter, which have to be wet, loosened and then removed by mechanical friction or rubbing. These are what make cleaning difficult, particularly the oily matter, itself complex and more or less sticky, which causes otherwise loosely adherent solid and sooty soil to cling to fabrics and to smooth surfaces.

The oily part can be considered as a mixture of grease of the lubricant type, of food oils and fats, that is, saponifiable oils, and of traces of free fatty acids. The latter are formed when saponifiable oils turn rancid or decompose. Soil is almost always found to be moderately acid, so that acids other those formed from the decomposition of fat are no doubt present. The proportions of these different ingredients vary with the type of article or surface being cleaned, but all are important.

Nature of Cleaning

In order for a solution of soap or synthetic detergent to remove soil, it must first wet it. Plain water fails to do this because of the oiliness present. That is why your windshield is not washed clean during a rain storm; the rain water fails to wet the oily film on the glass and so runs off zigzag in streamlets. When a detergent is present, the solution wets both glass and soil so that the latter can be readily loosened. The same thing is true in washing dishes and in washing clothing —wetting the soil and the surface to be cleaned is the first step, including penetration of the solution to the underlying surface to which the soil sticks.

The next requirement is that the soil be separated into small particles dispersed throughout the detergent solution, and prevented from coagulating into clumps which might settle again on the cleaned articles. In other words the cleaning solution must have emulsifying, wetting, *and* dispersing power. A good detergent like soap is high in wetting power, in ability to emulsify oil, and in dispersing power—the ability to suspend solid particles and prevent their redeposition.

Synthetic detergents were originally developed, not because of a scarcity of soap, but to overcome its disadvantages. While soap is the best possible general cleaner in soft water, it is not so good in hard water. The calcium and magnesium salts which make the water hard, give soft gummy precipitates by reaction with soap, which stick to the article being cleaned and are as difficult to wash off with excess soap as the original soil itself.

This inconvenient property of soap involves not only additional labor in cleaning, but increased cost. Municipally softened water may contain 3-5 grains of hardness per gallon. For example, St. Louis softens its water to about 5 grains. Some cities use hard water—like Champlain-Urbana with 17.5 grains, Dayton with 21 grains, and Canton, Ohio, with 30 grains of hardness. Probably an average figure more or less representative of the hard water of the country would be 10 grains per gallon or 170 p.p.m. It is therefore desirable for general household cleaners to be effective in water of at least this degree of hardness.

Nature of Surface-active Agents

In comparison with soap all synthetic detergents are resistant to hard water, and also to mild acidity, which decomposes soap with the formation of insoluble fatty acids. Synthetics naturally differ among themselves with respect to these properties because of wide differences in chemical structure. Some compositions are better suited to one application, some to another.

Many types of compounds having surface-active properties have been developed and thousands of patents have been issued to cover such compounds. Some are merely wetting agents to give improved wetting power on different types of surfaces and in different media, while others are detergents having efficient cleansing action. Actually, wetting agents merge into detergents, so that a strict line of demarcation cannot always be drawn.

In addition to original use as textile agents, many applications have been found in widely divergent industries. Because of very different uses, many compounds have been synthesized or "tailored" to meet particular needs. Wherever wettability of a surface is a factor, special surface-active agents become useful, as in spraying vegetation with an emulsion that will actually wet the leaves, in cleaning dairy equipment and preventing the formation of "milkstone," in dispersing pigment in both oil and in water paints, in washing and sterilizing bottles, in cleaning metals prior to plating, in emulsifying oils and waxes in cosmetic products, etc.

All surface-active agents including soap, combine polar and non-polar groups in the molecule; this is about all that the many types have in common. For example, to take a soap such as sodium stearate, which has the formula $CH_3(CH_2)_{16}COONa$, or RCOONa with R equal to a C_{17} alkyl chain, the polar group is $-COONa$ and the nonpolar group is represented by R. This would be an excellent detergent in hot water, say 140°F., which is frequently used in commercial laundries; in cold water its solubility is too low for it to have the same degree of efficiency. In fact, sodium stearate is a major ingredient in commercial laundry soap. The balance achieved in soap between the polar group at the end, and the straight hydrocarbon chain to which it is attached, appears to be ideal for detergent ability. The reactivity of this particular polar group, $-COONa$, constitutes its greatest disadvantage.

The polar groups most frequently used in surface-active agents to produce water solubility include sulfate, $-OSO_3Na$; sulfonate, $-SO_3Na$; amine $-NH_2$, amide, $-COONH_2$, and other substituted nitrogen groups; and oxygen-containing groups such as ester, $-COOR$; hydroxy, $-OH$; and ether, ROR. The presence of unsaturated bonds in a hydrocarbon radical also promotes water solubility. Acid groups such as sulfate and sulfonate are usually neutralized, mostly with caustic soda; basic groups such as amine and substituted ammonium are also neutralized, mostly with hydrochloric acid, thus giving organic salts in both cases.

The relative balance between the two opposites—polar and non-polar groups—determines the degree of surface activity of the compound. The general phenomenon of surface activity is related to the extent of concentration of the molecules of the substance at the surface of a solution, and to the degree of orientation of these concentrated surface molecules. In aqueous solution, soap molecules are pictured as concentrating in the surface layer, and lining up in this surface layer in more or less parallel rows, with the $-COONa$ group in the solution, and the hydrocarbon group sticking out toward the air. At a water-oil interface, the $-COONa$ group in the surface molecules would be dissolved in the water, the hydrocarbon group in the oil.

Detergents are in addition distinguished by the fact that within the solution, groups of ions or molecules or both, become associated to form *micelles*. With anion-active detergents such as soap, these micelles are negatively charged. Because of their ability to associate in this way, they are termed colloidal electrolytes.

As the chain length of the nonpolar portion is increased, the solubility of the compound in water is decreased. A relatively high molecular-weight nonpolar or hydrocarbon portion is desirable for agents to be used as detergents, while a relatively low molecular-weight nonpolar portion usually gives greater effectiveness as a wetting agent. Lathering properties are related to solubility and to surface orientation. If an agent is too soluble or too insoluble it will not produce a copious lather. The detergent types of surface-active agents have been found to be better foam producers than the strictly wetting-agent types of products.

Branched-chain hydrocarbon groups give marked wetting power; the closer packed straight-chain hydrocarbon groups give good detergency. Placing the water-solubilizing or polar groups in the middle of a branched chain increases wetting power; placing the polar group at the end of a long straight-chain hydrocarbon group increases the group of properties which make up detergency.

Types of Surface-active Agents

Classification of surface-active agents is difficult because a number of compounds produced in small amounts do not fit into any of the general classes which can be selected to cover fairly closely related types of compounds. The following cover the more important types. With each class is given one or more examples of the better known commercial products as designated by trade name:

(1) Sodium salt of sulfonated alkyl aryl compounds:
Nacconol NR, Santomerse 1, Oronite, Swerl

(2) Sodium alkyl sulfates and acyl glyceryl monosulfates:
Duponol WA, Gardinol WA, Arctic Syntex M, Igepon AP, Dreft, Vel.

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The Alchemist in Art

• **By Chester G. Fisher**

PRESIDENT, FISHER SCIENTIFIC COMPANY, PITTSBURGH, PENNSYLVANIA
RECIPIENT 1947 AWARD, PITTSBURGH SECTION, AMERICAN CHEMICAL SOCIETY.

The author of this article is the world's foremost collector of original paintings and etchings pertaining to alchemy and the early history of science.

The famous Fisher Collection of Alchemical and Historical Pictures is the largest and most comprehensive to be found anywhere. Historically, it is priceless. Scientists and historians for generations to come will be grateful that Mr. Fisher had the vision and the desire to assemble this inspiring pictorial record of workers of the alchemical period, their laboratories and apparatus, and their scientific beliefs.

Illustrations courtesy of Fisher Scientific Company.

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In order to understand better why the alchemist was a favorite subject for canvasses by the old Dutch masters and why we have such a splendid pictorial record of his activities, some appreciation of his place in history is desirable.

In the early beginnings of chemistry—commencing with the time of the skilled metal workers and expert goldsmiths in Egypt about 3,000 B. C. and following through to the atomic theory of 1808 and what might be called "modern chemistry"—the most colorful era was the "Alchemical Period". In a broad sense, alchemy was really the chemistry of the Middle Ages, and it is unjust to confine the consideration of alchemy to the attempt of gold making of the 16th and 17th Centuries.

The Egyptians, it is well known, were skilled in the art of metallurgy, enameling, glass-tinting, the extraction of plant oils, and dyeing. For this reason Egypt or Khem, the country of the black soil, has been pictured as the motherland of chemistry. Thus, the craftsmanship of the dark country became known as "al Khem" which word came to the Western World as "alchemy".

The "Alchemical Period" might be said to have started with the attempted transmutation of base metal to gold in China at about 300 B. C. From there it appears to have passed to the Arabs and to the Egyptians, and hence to the Europeans, although the "Alchemical Period" is generally thought of as the much shorter era, from the 14th to 18th Centuries.

The Atomic Age with its transmutation of elements and release of tremendous energy has lifted from the alchemist the false characterization placed upon him by some. Actually, the alchemist was the serious chemist of his time. His search for gold and the fruitless hunt for the elixir of life were undertaken primarily at the request of noblemen and governments eager for the power that the secrets would give them.

The modern chemist, armed with a far greater array of useful instruments and apparatus, has succeeded where the alchemist failed—this time in a world-wide "battle of the laboratories" for the secret of atomic energy. One significant difference between the 20th and 17th Century scientists is that the alchemist was forever trying to discover a lost art, to find a secret recipe, whereas his modern counterpart sought and found something entirely new.

Beginning at about 1400 A. D., European artists, particularly the Dutch, became interested in painting the alchemist. The Dutch School which flourished in the 17th Century painted many pictures of the alchemist who was a most spectacular figure of that time. These

THE ALCHEMIST, by David Teniers, Jr.

pictures pertaining to alchemy and the early history of science became scattered throughout Europe and practically every outstanding Collection of Old Masters in the art galleries of Europe has at least one alchemist painting. Only since the turn of the 20th Century, however, has there been any serious attempt to gather together paintings, etchings, and prints of these pictures.

One such Collection was that of the late Sir William Jackson Pope, Professor of Chemistry at the University of Cambridge, England. Another was the Fisher Collection gathered together by Chester G. Fisher, President of Fisher Scientific Co.—one at a time—over a 30-year period, and now in the Fisher Scientific Company offices and laboratories in Pittsburgh.

These two collections gradually were enlarged until each became the largest and most comprehensive in its country—the Pope Collection abroad and the Fisher Collection in the United States. When Sir William Jackson Pope passed away in 1939, Fisher's agents negotiated the purchase of the entire Pope Collection which was brought to America and is now a part of the Fisher Collection in Pittsburgh.

Soon after the Pope Collection arrived safely in America, Dr. John Read, Professor of Chemistry at the University of St. Andrews, Scotland, stated in the English publication "Nature":

> "It is a sign of the great interest taken by American chemists, both academic and industrial, in the historical evolution of their science that an American corporation should take such pains in building up a purely historical collection of the kind under notice. While congratulating the United States most cordially on her clear vision and good fortune in this matter, all British chemists who appreciate the interest, inspiration and educative value of historical chemistry will entertain a feeling of regret that a Collection of such outstanding merit as that of Pope could not have been preserved in Cambridge."

Professor Read's comment emphasizes the fact that the Fisher Collection of Alchemical and Historical Pictures preserves for modern chemists and historians in America a large, pictorial presentation of the men, the apparatus, the ambitions and a record of the scientific beliefs of an age from which chemistry emerged as a distinct and systematic branch of knowledge. The alchemist truly was the "ancestor" of today's chemist.

Included in the Fisher Collection at present are approximately 36 original oil paintings, the works of such 17th Century artists as Bega, Van Slingeland, Teniers, the Younger, etc. Many of them are meticulous in detail and all have a pleasing style which is sometimes

THE CHEMYST, by Cornelis Pietersz Bega

lacking in works of the modern school.

The paintings in the collection are subdued in tone—the alchemist's laboratory was lighted none too well—and in general they portray the alchemist as a serious experimenter. In obvious contrast to today's most modest laboratory is the lack of equipment and apparatus.

Also in the Fisher Collection are a large number of rare old engravers prints, many of which were copies from famous paintings in European museums. Some, from a later period, pertain to events or personages of the 18th and 19th Centuries.

In addition to the paintings and original engravings which have a value as collectors items, the Collection has become an outstanding repository for photographic prints concerning the alchemist and the early chemist. The entire Collection, in fact, has been a source for textbook illustrations and reproductions wherever the history of science is presented.

A few representative examples of the alchemist in art have been reproduced here in order to reveal the quality of the artist's work and some of the alchemist's activities. The following facts about three typical pictures will help the person viewing the illustrations to appreciate the subject a little more.

The Alchemist
by *Teniers*

David Teniers, the Younger, a member of the Old Dutch School of painters, was born in Antwerp in 1610. He was knighted by the Throne and acclaimed by the people, as were Van Dyke and Rubens. Teniers did very creditable work in his early twenties and continued painting until he was quite old. During this time he produced a very large number of paintings. He is quoted as having said that it would require a gallery two leagues in length to contain all his pictures.

His paintings of the alchemist have materially influenced the idea of the appearance of the early alchemist's laboratory.

The reproduction of a Teniers painting here is from an original painting which David Teniers made, signed and dated "1648". In viewing the painting from which this illustration was made, one is impressed by the artist's effective use of rich shades of brown, the true simplicity of its drawing, a consciousness of the depth of the laboratory and the correctness of detail. This Teniers painting was privately owned in England for many years before it was acquired by Sir A. S. Hunter in 1852. About 17 years ago this picture was acquired from a private home at Mortimer Hill, Berkshire, and brought to the United States, by Chester G. Fisher. It is now in the Fisher Collection.

AN ALCHEMIST IN HIS STUDY, by Egbert van Heemskerk

This particular picture has become the typical one of the alchemist. It has been carved in wood, cast in bronze, reproduced in full color and shown in many scientific books.

The Chemyst
by *Bega*

Among the pictures acquired with the Pope Collection, one of the outstanding works is a painting, "The Chemyst", by Cornelis Pietersz Bega. Pope purchased this fine painting along with others of the J. C. W. Sawbridge-Earle-Drax Collection in March, 1935, when Christies in London offered it at auction.

"The Chemyst" is painted on a wooden panel and is unusually well done. It is notable for its lifelike rendition of flesh tones and for the natural quality of the daylight and the highlights produced by it. This painting is outstanding also because of Bega's meticulous attention to details and its very fine coloring. The use of various delicate tones of heliotrope and blue makes "The Chemyst" a painting that is one of Bega's best and ranks it with the great alchemical paintings.

Bega was born in Haarlem in 1620, the son of a sculptor, Peter Begijn, and died in 1664.

The Alchemist in His Study
by *Egbert van Heemskerk, The Elder*

The painter of this picture, Egbert van Heemskerk, was a member of the 17th Century Dutch School. His son was also a well known artist and painted another alchemist picture now in the Fisher Collection.

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Some Advances in Physics

• **By Sister M. Thomas Aquin, O.P., Ph.D.** *(Fordham University)*
BISHOP McDONNELL MEMORIAL HIGH SCHOOL, BROOKLYN, NEW YORK

In recent decades no branch of science has progressed more rapidly than physics. Fundamental discoveries concerning the structure of matter a half-century ago led to much new knowledge, to improved scientific techniques, and to startling practical applications of the findings of physicists.

Even though the list is incomplete, workers in every field will be impressed by the striking advances that are mentioned in this brief review.

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The discovery of x-ray and radioactivity at the close of the 19th century marked the beginning of a period which today is referred to as the Electronic Age. Within the past five decades we have witnessed the development of the radio, sound motion pictures, television, color photography, the Diesel engine, the automobile and the airplane. Equally remarkable advances have been made in the field of theoretical physics. This period is unparalleled in scientific accomplishment.

When Roentgen discovered x-rays in 1895, every laboratory in the world took out its old Crooke's tube to produce x-rays. Becquerel, while studying x-rays, found by accident that uranium emits invisible radiations and thus, in 1896, discovered radioactivity. In 1897, Sir J. J. Thomson was the first to recognize the electron. The timeliness of the discovery of x-rays and the electron is shown by the fact that two of the three kinds of rays which come from a complex radioactive source could be explained at once.

In 1898, Professor and Madame Curie isolated the element radium and in their studies ascertained that like uranium, other elements decompose when radioactive rays are emitted. It was Planck, however, who in 1900 sponsored the theory that energy or radiation is not continuous but exists in small exact units measured in terms of "quanta." In 1902, Rutherford and Soddy formulated the startling theory that radioactivity was a spontaneous natural process of transmutation of certain elements. However, the progress from the discovery of radium in 1898 to that of the fission of uranium in 1939 was slow.

Scientists began anew to wonder about the structure of the atom. Rutherford worked out the theory of the scattering of alpha particles on the basis of the nuclear idea, and Geiger and Marsden in 1912 tested the theory by counting the number of alpha particles scattered at various angles. Moseley confirmed the nuclear view, and in 1913 established the concept of the atomic number, the number which has been used ever since to identify chemical elements.

Rutherford, in 1919, found that a nitrogen atom bombarded by an energetic alpha particle from radium could be transmuted into a new oxygen atom and hydrogen. For the first time in man's history the atom of one *stable* chemical element was transmuted into another.

Compton (1923) measuring the wave length of x-rays scattered by water, found that the wave length was slightly lengthened and gave an explanation of the effect based on Planck's quantum theory. The Compton effect made it clear that bullets of light particles of radiant energy, photons, possessed momentum and energy.

In the wonder year of 1932 seven great discoveries were made. Chadwick, discovered the neutron, the effective bullet to break up atoms; Anderson, the positron, a particle of positive electricity with approximately the same mass as the electron; Urey, heavy water; Cockroft and Walton brought about the transmutation of lithium by firing into it hydrogen nuclei; the latitude effect on cosmic rays was discovered by Hess; Van de Graaff devised his generator for high voltage, and Lawrence brought to practical use the cyclotron which may give atoms a speed up to sixty million volts and thus transmute every known element into another.

The discovery of artificial radioactivity by the Curie-Joliots occurred in 1934. After 1934, outstanding physicists analyzed the material and energies obtained by bombarding the uranium atom by slow neutrons. When it was proved that U-235 was broken up, the great reservoir of power of the physicists of America and England broke loose to bring about in five years a result, the achievement of which was not expected for decades—the production of the atomic bomb.

Many discoveries were made during the war. In 1940, McMillan and Abelson identified neptunium and plutonium and Seaborg discovered americium and curium. The betatron, a device for producing high energy particles, was developed by Kerst. Doubtless the cyclotron and betatron will be superseded by the synchrotron which promises to give us energies of three hundred million volts.

The wonder of radar had its birth for America in 1922 when Taylor and Young observed that radio signals were reflected by steel buildings and passing ships. Radar is a method of extending human vision by the use of radio waves. The word means radio detecting and ranging. Radar operates on two basic principles: the first is that radio waves rebound from solid objects similar to echoing sound waves. The second is that very

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Research at the Children's Fund of Michigan

• **By Icie G. Macy Hoobler, Ph.D.,** *(Yale University)*
DIRECTOR, RESEARCH LABORATORY, CHILDREN'S FUND OF MICHIGAN, DETROIT, MICHIGAN
GARVAN MEDALIST, 1946

The distinguished scientist who wrote this article has for many years conducted researches dealing with nutrition and growth in infancy and childhood, the chemistry of the red blood cells in health and disease, the composition of human milk, and other phases of biology related to nutrition. In World War II the data obtained by Dr. Hoobler in her studies with women and children were considered by the National Research Council in establishing national dietary prerequisites for good nutrition.

The public does not yet appreciate the importance of nutrition in increasing the vitality and strength of the nation. The dangers of underfeeding and misfeeding must be taught to the entire population. Teachers of science can help by properly instructing the children under their direction. The children will teach their parents. The school lunch is an easy place to begin.

In 1946 the American Chemical Society awarded the Francis G. Garvan Gold Medal to Dr. Hoobler. It is given for outstanding work in chemistry performed by a woman.

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During approximately twenty-five years the program of the Research Laboratory of the Children's Fund of Michigan has had a single objective: the securing of information which would be useful in efforts toward improving the health of children. Since the future health of an unborn child may be profoundly influenced by parental factors, especially maternal, studies of children quite naturally encompass investigations of women during child-bearing and child-rearing. The major medical research projects of the laboratory have been investigations of the metabolism of pregnant women and nursing mothers, the composition of human milk, the growth of infants, the chemistry of red blood cells in health and disease, nutrition and chemical growth in childhood, and the nutritional status of children and mothers. Throughout the quarter-century we have been able to maintain an integrated program in which the entire laboratory staff participated, and we have been fortunate in having sponsors who permitted us to conduct studies which required heavy investments in personnel, equipment, apparatus and supplies over periods of many months or years.

The Research Laboratory dates its existence from the establishment of the Nutrition Research Laboratories of the Merrill-Palmer School and the Children's Hospital of Michigan, in 1923. A research program was initiated which would conform with the objectives of Lizzie Merrill-Palmer, founder of the school: "Girls and young women shall be educated, trained, developed and disciplined with special reference to fitting them mentally, morally, physically and religiously for the functions and service of wifehood and motherhood, and the management, supervision, direction and inspiration of homes". Studies were started which encompassed determinations of the composition of human milk, the effect of diet and environmental factors upon the production and composition of human milk, the variations in the amounts and chemical structure of milk produced at different times during the day, at different intervals in the nursing period, and from the two breasts. Coincidentally, investigations of the metabolism of women during pregnancy and lactation were inaugurated. The investigations provided data for numerous papers which were published in various scientific journals.

These early studies, in addition to expanding the available knowledge of the composition of human milk and processes of maternal metabolism, emphasized several important considerations in biological research which were not widely accepted at that time. The new information supported our conviction that experimental results obtained with animals must be confirmed with human subjects before they can be accepted completely, and confirmed our belief in the wide variation which must be expected from normal human beings. Thus, two distinct types of investigations must be employed to obtain greater understanding of body processes. One is the survey, or cross-sectional study in which isolated observations are made with each of a relatively large number of subjects. Such studies provide average and range values which are useful with large groups of the population but have only limited value as standards for individuals. In longitudinal studies information is obtained from fewer subjects but over longer periods of time, which permits evaluation of normal variation in the individuals studied as well as among the different subjects.

Since 1931 the Research Laboratory has continued as part of the Children's Fund of Michigan. As the staff and facilities of the Laboratory expanded, the scope of the studies was broadened and additional investigative programs were inaugurated. In all of these we have studied individuals as completely as possible, over as long periods of time as staff and equipment permitted, with our own resources supplemented through the cooperation of trained workers in many other fields. The data have contributed to a better understanding of the patterns of response of mothers, infants and children, thereby aiding efforts toward improving the nutrition and medical care of children.

Since the composition of blood is intimately involved with health, a portion of the efforts of the group was devoted to determinations of the distribution of fats and minerals in the blood fluid and in the blood cells of healthy children and those with disease. In an investigation of the growth of infants during their first year of life 550 babies were supplied with the equivalent of 280 tons of fluid milk, 28 tons of vegetables, 5 tons of fruit, 2.5 tons of lemon juice powder, and 300 gallons of cod liver oil to assure measurements which would not represent the growth of malnourished infants.

In the same period, research was inaugurated to determine as completely as possible the amounts of materials which the healthy child takes from his food and incorporates into his body, i.e. chemical growth. This investigation required continuous supervision of active, healthy children throughout the 24 hours of every day for periods of as long as eight months. Every bit of food and beverage eaten by each child was weighed or measured and sampled for analysis; all urine and feces was collected and analyzed to ascertain the amounts of food components excreted by the body. This was accomplished without appreciable disturbance of the children's usual routines of school, eating, playing, and sleeping. Results of this study have been published in a number of papers and in two volumes of *Nutrition and Chemical Growth in Childhood*, containing 1502 pages. The final volume is being prepared.

Twentieth century advances by the medical sciences have offset the declining birth rate in the United States by reducing infant mortality over 85 per cent, and they have increased the median age of the entire population by 6.1 years. The same period has seen the birth and development of the science of nutrition: the transformation of the proper kinds and amounts of food into development, growth and activity. As the science of nutrition has evolved we have been able to keep pace with it, employing new techniques developed by others and constantly seeking better or less tedious methods of analysis in connection with our own research.

The possibilities of nutrition in increasing the vitality and strength of a nation have long been clear to physicians and other scientists. However, until the recent war was imminent there was no concerted attempt to apply the available knowledge of nutrition to our entire population. Widespread public recognition of the importance of nutrition to national health and vigor was not gained until results of physical examinations for the armed services showed that for a large percentage of rejections poor nutrition was a major or contributing factor. The Committee on Food and Nutrition, later the Food and Nutrition Board, of the National Research Council was asked to establish dietary prerequisites for good nutrition, and in 1943 published *Recommended Dietary Allowances* (National Research Council Reprint and Circular Series 122) which became the standard for evaluation of dietary adequacy. The mass of data obtained with women and children by the Laboratory was considered in the establishment of these values. The Recommended Dietary Allowances were improved and expanded in 1945.

During the war, new programs were devised to improve nutrition and existing ones were expanded. Public and private agencies combined to combat the menace of underfeeding and misfeeding. Programs were established to "recondition" prospective members of the armed forces, thereby increasing our fighting strength, to improve the nutrition of industrial workers, thus augmenting production of the materials of war; and to assure good nutrition for mothers and children so that the nutritional status of American people would never again be as poor as upon entering World War II. Individuals and organizations engaged in research were organized to prevent duplication of effort and those with specialized staffs and equipment were assigned suitable research projects. During the war years, in addition to speeding the publication of results from experimental work already completed, the Research Laboratory of the Children's Fund of Michigan reinvestigated the composition of human milk and the metabolism of nursing mothers, using newer, faster, and more accurate methods than were available for the earlier studies.

In addition to the stimulation of national efforts toward application of our knowledge of nutrition, the war years produced an acceleration in the development of methods for determining the nutritional condition of individuals and groups. Height-weight tables have never been satisfactory as an index of nutritional status and until recently, the physician was dependent largely on his subjective evaluation of nutritional status. The practical methods available were inconclusive or they required more time or more highly trained laboratory personnel than was usually available. With new methods which require only a few drops of blood from the finger, information about nutritional status may be determined with respect to hemoglobin, the red pigment which carries oxygen to the cells; protein, composed of amino acids often called the "building blocks" of muscle; vitamin C, which prevents scurvy; riboflavin, which prevents pellagra; and vitamin A and carotene, which are associated with nightblindness. These new techniques have made possible studies of large groups of people. Our Laboratory has just completed studies of several groups of children and similar investigations are being made by other laboratories. As these methods are expanded and their use standardized it will be possible to evaluate quickly the nutritional status of a group of children and find the individuals who are definitely malnourished.

The need for an aggressive national nutrition program was not reduced by the termination of hostilities. Results of nutritional surveys indicate that a majority of dietary inadequacies could be corrected by the addition to the diet of one or two foods. Often the addition of a single food, such as tomatoes, oranges or milk will change a poor diet to one which adequately meets all

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Teaching the Handicapped Child

• **By Margaret Livingston, M.E.** *(University of Pittsburgh)*
H. C. FRICK SCHOOL, PITTSBURGH, PENNSYLVANIA

Teachers of science, like all other teachers, occasionally become disturbed at the slow rate of progress of the supposedly normal pupils in their classes. It will do such teachers good to read how carefully specialists in teaching handicapped children adjust their instruction to the abilities and the needs of the individual pupil.

The lesson of patience is taught in every paragraph of this interesting article.

"Fitting education to the child and society" orients Pennsylvania's program of special education. It aims to promote an appreciation of the fundamental principle that schools are organized and maintained for the benefit of the child.

Handicapped children have definite limitations that interfere with their growing meaningfully and successfully in the regular grades in most schools. For these, education has been simplified by the provision of special class facilities. Experience with diversified teaching materials and methods of instruction has proved that there are activities of great educational value for such children which they can perform successfully. These activities are largely manual.

How Does the Handicapped Child Learn?

The process of learning for the handicapped child is the same as for the normal. Learning may be thought of as a continuous process of adjustment on the part of the individual. It takes place in the same way in all individuals, regardless of differing rates of learning ability. Learning, explained simply, means that the individual is finding and establishing new and better ways of responding or behaving in any situation.

How Educate the Handicapped?

In any plan of education, the individual is the center; the purpose is his complete harmonious growth and development. Recent developments in the study and treatment of the handicapped tend to emphasize each child's special abilities, to encourage the growth of his capacities possessed, as well as to minimize his defects so that he may live as happily and effectively as possible.

John Dewey says, "The child is the starting point, the center, the end. It is he and not the subject matter which determines the quality and quantity of learning." With this thought in mind, the teacher should endeavor to have an understanding of the background, the interests, the abilities, and the attitudes of each child. And according as she discovers the stage of his development, she plans and carries out a program. In other words, the situation is planned to meet the needs of the child, the child is not fitted into a planned situation.

The handicapped child may be one with mental difficulty where the development of the nervous system is retarded or very slow, or perhaps it may be one with special sensory or motor defects. General psychology as well as common observation emphasize the fact that knowledge is dependent upon sense perception, and learning is conditioned by it. If this type of experience is so valuable, obviously the first thing in the education of children along this line is to be sure that the organs of sense are in a condition to be affected by the stimuli presented. The normal child may secure all the sensorimotor training which he requires from his plays, games and playful occupations, but the low-grade mental defective, the young mentally deficient child, and the child with special sensory or motor defects should have instruction and experiences that appeal to all senses.

The fact that in children the sense of touch is most delicate should encourage teachers to make the best use of it, not only in handling objects, but also to explore and to be alert to its appeal and use in the development of new units of work. Repeated experiences with little variations are much enjoyed and profitable to the handicapped child.

It is also well to remember that as Dewey teaches, no training of sense organs in school, introduced for the sake of training, can begin to compete with the alertness and fullness of sense—life that comes through daily intimacy and interest in familiar occupation. No matter where the child is living, material is there,—living, vital material, to which the child is constantly reacting. It is here the teacher of special education has the privilege of building life situations into units of interests that will encourage the growth and development of her pupils. The successful development of a unit depends on guidance to bring about needed experiences. This means that the teacher challenges and weighs the values of what is happening at every step of the way for each student.

Crafts Encourage the Developmental Growth of the Mental Deviate

We start with the selection of a suitable unit. The integration of instruction is an acceptable method of teaching the mental deviate the country over. The selection of the units should be governed by the needs of the pupils. Usually, it is the special teacher who selects the unit and cooperatively launches it with the students. The unit should captivate the imagination and interest of pupils, and include rich possibilities for handcrafts as well as be within the practical everyday environmental

experience and needs of the pupils. Begin with the known—lead up to the unknown.

In my classroom this year with twenty-two mentally deficient children, I am working on the unit "Time". I shall mention some of our craft activities and experiences that give some training to develop motor ability, and give satisfaction in accomplishment. They serve as a means of expression—of interpreting and giving form to ideas; of solving problems; of vitalizing and motivating interest in other content and subjects; and of developing understanding of the changes made by man.

In September, we started with time in reference to the season, autumn. We gathered flowers, fruits, and leaves. The child with the least ability, which happened to be Albert with an I.Q. of 50 and a chronological age of twelve, fastened with bits of Scotch tape over a blackboard that he had washed so clean, a variety of leaves his elder brother had pressed for him. Then came some fun for Albert when he carefully dusted the eraser around the leaves fastened to the board in the hope of seeing the picture of the leaf left on the blackboard. Children with a little more ability drew around the leaves and tried to color the drawings. Others drew around the leaves and tried to color the leaves just like the real ones. Children with additional ability sketched their own drawings of leaves and blended their own coloring as well. Two others with still more ability worked out a design for a large note book cover with leaves as the motif.

The children brought in old clocks which were mostly alarm clocks of different sizes and shapes. We got two of them to run and keep time. It was then the question came up: What was the first alarm clock? So it was at this time we began making clocks. First we studied our own shadows on our way to and from school. When was our shadow longest and shortest? We constructed shadow clocks starting with the simple one of using a measuring stick and proceeding up to a very well constructed sundial. From experiences initiated in our reading and from pictures brought in from the Carnegie Library along with clippings, schedules, and other materials came the making of an hourglass from two gallon glass jugs and sand, which we timed to empty in an hour. We measured time by burning candle and rope. We constructed a Chinese water clock from four gallon cans obtained from our cafeteria and some discarded cylindrical curtain rods. That we timed to empty in one-half hour. One of our boys found part of the works and the face of a very old grandfather clock thrown away in an alley. We were all overjoyed, and we started to build the framework for the grandfather clock. We wanted it to look just right; so we all began to look for pictures. The more able pupils found information they could read with teacher guidance. We now have the framework constructed, but we haven't gotten the wooden works to run yet.

At Hallowe'en, Thanksgiving, Christmas, Easter, kite time, and other holidays we stop work on the general unit and direct our work around the holiday. At Hallowe'en we made our costumes from salvage material. Some were made from wrapping paper and others from old lace curtains. Here our more apt pupils had opportunity to be creative, while our less developed ones followed very simple directions given by the teacher or an older pupil but they too had an opportunity to use their own ideas. We gave each other suggestions and made a happy time of it.

At Thanksgiving, we construct some phase of the historical background of the holiday. This year we painted a large autumn mural covering one end of our classroom. We then constructed one end of a log cabin, actual size, with a depth of about two feet, and placed it against the mural scene. Then we made life-size figures of Pilgrims and Indians from large pieces of cardboard which our boys carried from a furniture store near our school. We molded from clay the food served at that First Thanksgiving, for the long table we placed in front of the log cabin. Lastly, we covered the floor in and about the scene with a thick mat of fallen leaves.

Christmas offers so many opportunities for the development of the handicapped with crafts. Here again we take some phase of the Christmas story and construct a floor project. Last year in the back of the room we built a stable and manger. We then constructed life-size figures of Joseph, Mary and the Others from large cardboard. I brought sacks of hay for the manger. I do not believe my pupils will ever forget the story of the First Christmas.

In the front of our classroom we constructed a scene as we would find it in our home on Christmas morning. We took rag paper and painted it dark blue and scattered confetti over it. This was the wallpaper for the scene in a modern home. We built a large fireplace of orange crates and paper. A few days before vacation we bought a Christmas tree which we trimmed with lights and milk bottle tops that had been made into a variety of pretty ornaments. Under the tree we always put the useful presents we have made for the parents along with our Christmas pie presents. Then we were ready for the Christmas party.

Supplementary Activities

Undoubtedly there will always be going on in a class work that is unrelated to the unit or that must be thought of as only supplementary to it. There is need for periods devoted to the development of important specific habits, attitudes, and skills. Then we have students who have matured to the place where their interest is not in building floor projects but in making useful articles for the home and for himself. Every opportunity should be given these pupils to progress to more difficult tasks as their skill and interest grow if the unit of study does not provide this opportunity. The teacher should make provisions for necessary supplementary activities when she plans a unit.

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Glimpses of East African Flora

• **By Reverend Vincent Deer, C.S.Sp., B.A.** *(Duquesne University)*
DEPARTMENT OF PHILOSOPHY, DUQUESNE UNIVERSITY, PITTSBURGH, PENNSYLVANIA

This out-of-the-ordinary article was written by a member of the Holy Ghost Fathers, the religious society which operates Duquesne University and other educational institutions. The society maintains many missions throughout the world, including a large number in Africa. While serving there as a missionary, Father Deer found the study of botany a pleasant avocation. His interest in the local flora and his long and close contact with the native people are reflected in this informal paper.

You will enjoy it.

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Not long ago I returned from missionary work in Africa. I had spent thirteen years there teaching in a combined secondary and normal school located in the Kilimanjaro Vicariate in Tanganyika, British East Africa. While I was principal of the school and superintendent of all the Catholic schools of the district I came to the conclusion that an introductory course in systematic botany should be added to the curriculum. I have no scientific knowledge of botany, but I began to gather material, make notes, and to prepare the natural color slides (Kodachrome transparencies) that I could make myself and which would be helpful teaching aids.

The recent world war curtailed the work sharply. Our supply of films soon was exhausted. Missionary and government school staffs were not increased. I preserved the notes I had made, however, and the following account is based on them. The plants I mention grow on the slopes of snow-capped Mount Kilimanjaro, 3° south of the Equator. The illustrations used here were made by projecting some of my color slides on a screen and photographing the screen.

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Plant Families teach us how small the world is. Botanists find that East Africa produces very few "new" species. Many of the plants grow elsewhere, and in others such variations as may be noted are only minor ones. Yet the plants make an interesting study, especially for background information. Each plant has an attraction of its own.

In a certain area we learned that our students needed a medicine for tapeworm. They insisted that one of their own native treatments was satisfactory. The seeds of a certain plant were boiled, then crushed and swallowed after a fairly long fast. A complete cure was effected in two days, but the treatment was rather drastic leaving the patient weak for some time. We had to determine if the medicine was suitable for use. The plant, called *Mrowe* in the Chaga language, was brought in and examined for clues that would identify it. We found that it fitted exactly into the Goosefoot family. Botanists, however, combine the Greek words for goose and foot into a family name—*Chenopodiaceae*. That is not too far removed from the name of the much more common remedy for tapeworm, chenopodium. Thus we learned that the native Chaga people had struck on a proper medicine. Scientific experiment has now taught us the right amount of it to use, and the treatment necessary to avoid some of its unpleasant non-essential effects.

A common American plant, *Chenopodium album*, is known as "lamb's quarters". It grows in almost any little patch of green around Pittsburgh. It was also common on the slopes of Mount Kilimanjaro. The people occasionally cooked it in the same way we cook spinach. They called it *Machicha*, but I think they did not use the name specifically because palm leaf hearts cooked in a similar way had the same name. Mentioning spinach reminds me that spinach belongs to the *Chenopodiaceae*. European gardens in our area grew plenty of it. Native children were encouraged to plant spinach in their school gardens. They were allowed to cook it at school and eat it themselves as an incentive to improve their diet.

The mints *(Labiatae)* are fairly common in East Africa, quite a large number of species being represented. Their scents can be recognized readily in the chill air of early morning. Unfortunately, however, I did not have at hand the information required for the sure identification of the mints we found. The native people used certain members of the family without, of course, understanding their relationship. My first practical encounter with the mint family occurred when I was working with some students setting up a few beehives. Bees are readily attracted by the scent of crushed mint leaves; so we gathered some leaves and rubbed them on the inside of the hives. Even before our task was completed bees had begun to scout around us. A native beekeeper among our teachers wanted to know who among the Africans had given me such information, for the use of mint in this way is a trade secret of the beekeepers of the tribe. They could easily keep this information from other people for they work at night and hang their hollow-log beehives high up in trees out of the reach of prowlers.

They had other uses for the same mint we used to attract the bees *(Hyptis* might be the botanical name for it, but the people called it *Matolo*, the "scented plant"). Its leaves are fed to cows to relieve certain digestive disorders and also to increase milk production. The latter advantage cannot be very great for the best of the native stock (Zebu cattle) do not produce more than two or three pints of milk a day. But its other use was of value. Some of the people complied with the sugges-

tion of the Department of Agriculture to plant much of it, secondarily for this purpose, but primarily to check soil erosion in their hillside gardens. The plant grows and spreads rapidly, has strong roots, and is not easily harmed by stripping its leaves.

The African people did not seem to have any personal medicinal uses for another mint (probably *Mentha viridis)* that the earlier missionaries had adopted for tea. But I did discover not long ago that some of our former students remembered that we administered it to them and they were beginning to keep its dried leaves on hand for stomach ailments. One of our missions used to serve mint tea every evening. I used to like it myself, but since the "Mountain" produced millions of pounds of coffee, and Kenya Colony began to produce plenty of "regular" tea, the mint tea disappeared from our table. I recall that at the change-over, the table boy used to come around with two teapots and ask whether we wanted "garden" or "store" tea.

Before I pointed out the Mexican prickly poppy to a few of our students it could be seen in brilliant patches on our school property. Its flowers are interesting in themselves, but what tempted the students to gather the seeds was its brilliant silver-green leaves. These plants brighten their surroundings markedly and they could be used to improve the native home plots. The purpose of the students was laudable, but the result was just about what we in America try to prevent by regulations against the picking of wild flowers. The prickly poppy has just about disappeared from our land. One little patch off the beaten track was all we had left.

The Chaga people believe that *Impatiens* (Fig. 5) brings fertility to the soil. It flourishes in the rich moist soil along the shaded banks of the mountain streams and irrigation furrows. Patches of the plant were left undisturbed for a year or two and then the land was planted with yams *(Colocasia antiquorum)* which also require plenty of moisture and good soil. Native medicine men use Impatiens. The tender leaves are baked inside a wrapping made of a banana leaf and given to children suffering from diarrhea. The results must not be very satisfactory, for children are brought in ever increasing numbers to the mission hospitals for treatment of this malady.

The *Bignonia Venusta* is my most unforgettable flower of East Africa. It is a fast growing climber whose dense golden panicles of trumpet flowers give it the English name "golden shower" (Fig. 2). It made a gorgeous shade for our porch, presenting an attractive appearance most of the year since it rarely lacked flowers. The trumpet vine, an American member of the same family, is a close counterpart although it does not bloom as profusely as the golden shower. Probably because it would not grow from seed, the native people had not yet taken the golden shower into their gardens although they had adopted some of the less outstanding flowers for show.

The Bignonia reminds me of two other show flowers common in European gardens in the Tropics. The Uganda flame tree produces orange-red flowers about five inches across, clustered in groups of four or five all over the tree. It blooms about half the year. Our Preparatory Seminary was set off in fine style by an avenue of these flame trees. Botanists call it *Spathodea Nilotica.*

For me, the other member of the family that is common in East Africa is a combination of "beauty and the beast," with the beast predominating and influencing our decision against it. This member, *Jacaranda Mimosifolia* in time produces panicles of pale blue flowers that have but a short life. It is a tree, and its objectionable features in my opinion are uncontrollable growth, unsymmetrical shape, and the almost unbearable odor of its dying leaves. Better gardeners than we are suggested that we prune the trees to bush size, but they gave no easy solution for disposing of the excess growth to avoid the foul odor. So we decided to uproot all our specimens and replace them with flamboyants and cassias. These are members of another family, the *Leguminosae.*

I have read somewhere that the family most widely represented by species in East Africa is the Pulse or Pea family *(Leguminosae).* It supplies the flowering cassias, acacias and flamboyants that line the streets of the towns. It provides the thornbushes (Fig. 4) that form the boundaries of many of the pastures and farm plots of the people. Some of its members furnish medicines, chiefly purgatives. One species gives a strong poison used in catching fish. Another yields a red dye that is used on the leather clothes of the Masai people. Still another supplies beads for rosaries. Several members of the family provide the seeds used by sorcerers in divining the reason for spells. One member supplies a thirst-quenching leaf. The family as a whole furnishes staple foods and even cash crops. The people plant beans to obtain one of their common foods. All the beans are the common property of the whole family, father, mother and children; but in their spare time women are free to plant cowpeas to obtain pocket money for themselves. The children are permitted to do the same; but if the father wants pocket money he draws on the common bean crop. Small flowers of the pea family may be seen growing almost everywhere. Probably this family alone would supply sufficient material for a lifetime of study. We regret that we can give it only brief mention here.

Everyone is familiar with the poinsettia as a Christmas flower. The bushes of this plant that grow in the gardens of settlers in East Africa reach great proportions in both the red and white varieties. The family is represented by other domestic and wild members. The *Spina Christi* is used as borders in rock gardens. The deep brown foliage of the *Acalypha* makes a fine garden background. The best wild member is the *Combretum.* It appeared on our property in two forms. It should be a vine with a strong stem. One of our specimens climbed to the top of a sixty-foot tree. Its stem was five inches in diameter, and its scarlet flowers covered the whole crown of the tree. Another specimen that found

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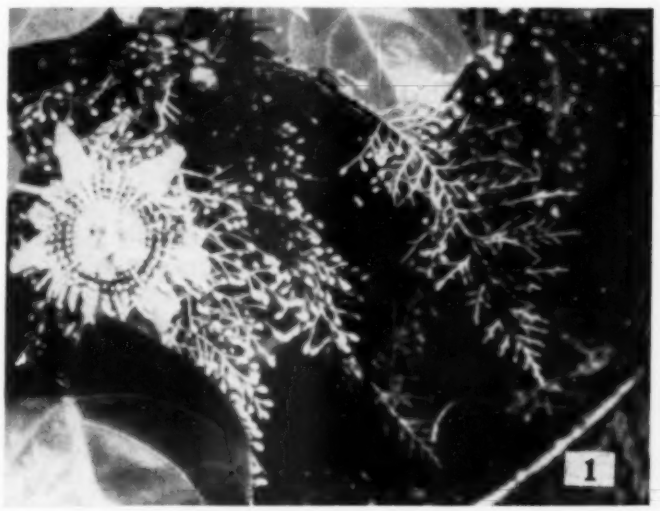

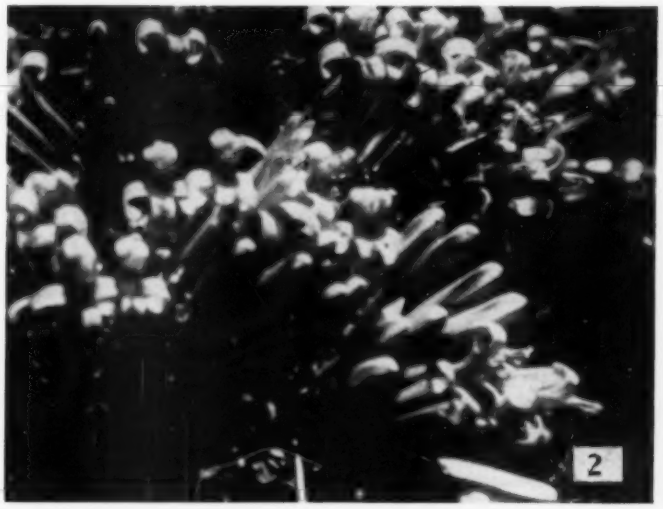

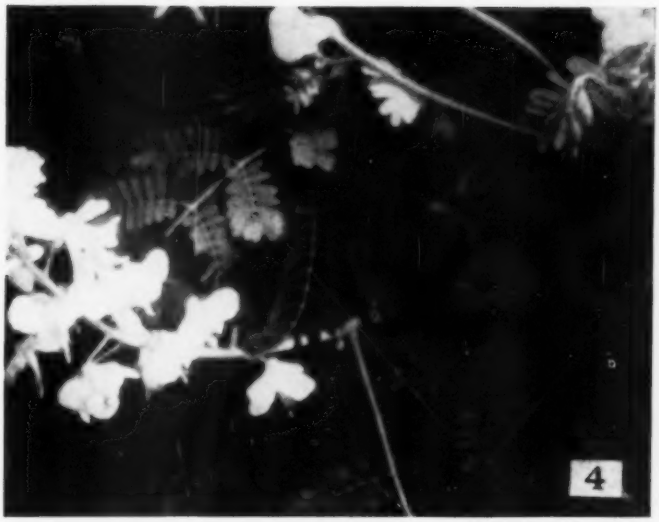

1. Passion Flower 2. Golden Shower 3. Glorious Lily 4. Thornbush 5. Impatiens 6. Can you identify it?

FLOWERS OF EAST AFRICA

A New Service For Teachers

• **By Bertha E. Slye, B.S.** *(Western Michigan College of Education)*
DIRECTOR OF MEMBERSHIP SERVICE, NATIONAL SCIENCE TEACHERS ASSOCIATION, WASHINGTON, D. C.

Successful teachers of science are always seeking new material to keep themselves and their classes informed of the latest scientific developments in industry. It is a far from easy task that never ends. Realizing the difficulties than confront the average teacher in this respect, America's greatest association of science teachers has recently instituted a new free service to its members, a service that has already proved its value.

This is a brief account of how the service operates.

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The problems of a science teacher in keeping up to date in a rapidly changing world are staggering. His opportunities for leadership in interpreting science are unlimited, but his responsibilities are greater. They often outweigh the opportunities even to the point of being a burden.

He must:

1. Keep informed about the many changes in contemporary living.

2. Keep a true perspective of educational problems in spite of the changes.

3. Read objectively, selecting with discrimination those items of interest to him and pertinent to his teaching.

4. Streamline his classroom technique to make effective use of the information.

5. Prepare and present an intelligent interpretation of those phases of science which affect his life and the lives of his students.

All this takes time, *which the science teacher does not have*! To fill the need, the National Science Teachers Association* has organized a Membership Service Department to select, evaluate, and distribute useful and timely science information for teachers.

The objectives of the new service, which is free to Association members, are:

1. To help improve science teaching by supplying teachers with information concerning developments in science.

2. To provide science teachers with supplementary information that will help them to relate the work in the science classroom to the world in which the students live.

3. To promote a program of evaluation of source materials for the teaching of science.

4. To provide better and more useful informational materials in science for teachers and students.

Source materials on new products and processes are of great interest to science teachers, for there is always a lag between the products of industrial and scientific laboratories and the courses of study in science textbooks. Frequently this gap has been bridged by commercial pamphlets and similar literature obtained from governmental agencies and other institutions. In recent years several of the larger industries have established educational departments which produce and distribute many types of supplementary teaching materials in science. Hundreds of individual companies also produce materials designed for possible use by teachers. As a result all teachers, and especially teachers of science, are faced with the problems of selection and of intelligent use that will not transgress the proprieties involved through bringing advertising material into the school.

The National Science Teachers Association takes the position that the use of such materials by science teachers shall be guided by two general criteria:

1. The material shall contribute effectively to the educational program as approved by the responsible educational authorities.

2. There shall be an absence of direct sales promotion. Although the name of the donating firm may appear, there must be no effort to persuade and no urge to buy or try.

In 1946, a N.S.T.A. committee of science educators headed by Dr. Harold E. Wise of Teachers College, University of Nebraska, worked in conjunction with the Consumer Education Study of the National Association of Secondary School Principals in preparing a report on "Specifications for Commercial Supplementary Teaching Materials for Science". Among other things the report included: (1) criteria for acceptable materials; (2) physical and content specifications for commercial supplementary teaching materials; (3) suggestions for materials needed by teachers; and (4) suggestions to producers of commercial materials.

Later, the Association consulted with the United States Rubber Company in the production of a booklet, *Serving Through Science*, a collection of radio talks given during the intermission of the New York Philharmonic Sunday Concerts. The company provided funds for the distribution of 5000 copies of the booklet to Association members. Through the cooperation of E. I. DuPont de Nemours & Co., the members received copies of the booklet *Plastics* prepared by the National Association of Secondary School Principals. Finally, the Association received a grant-in-aid from General Motors Corporation for the development of cooperative projects between science teachers and industry, and the Depart-

*Address, 1201 Sixteenth Street, N.W., Washington 6, D.C.

ment of Membership Service was established to initiate and promote such projects.

A major service of the new department has been the collection and evaluation of industrial booklets, copies of radio talks, and reprints of articles from science magazines submitted by industrial concerns. In evaluating these materials the members of the evaluating committee, representative of all fields of science teaching, use an elaborate rating scale. It includes such important features as:

1. **Format:** physical features, size, cover, paper stock, binding, printing, color, etc.

2. **Content:** Timeliness of information, instructional value, usefulness for teachers, usefulness for students, illustrations, readability, accuracy of statement, degree of sales promotion, grade and subject placement.

Each committee member rates the item as superior, good, satisfactory, weak, or unacceptable. From the many items judged either superior or good, a number are chosen for inclusion in a packet of eight or nine items and negotiations for their distribution are completed with the companies represented.

The distribution of Packet No. I and Packet No. II of "Science Information for Science Teachers" brought into focus the services of the department to Association members. Packet No. I, distributed in April, 1947, contained the following items: a "sketchbook" of engines prepared by the General Motors Corporation; a discussion of Time Reform presented by the Association of American Railroads; "Trees of Tomorrow" from the American Forest Products Industries, Inc.; "An Outline of Aluminum" from the Aluminum Company of America; "Five Years of Synthetic Rubber" by the United States Rubber Company; "Application of Atomic Power" from the General Electric Company; "Cereals" from the Cereal Institute, Inc.; "Air Transportation" by the United Air Lines; "Chemistry Leaflet" by Science Service; and "The Atom—New Source of Energy" by the National Committee on Atomic Information.

Packet No. II,* which reached science teachers in September, 1947, contained material dealing with wheat, fertilizers, forests, rubber, gas, vegetables, plastics, and water.

Other projects have resulted from the cooperative efforts of industry and the Association to improve the evaluation and distribution of science information. Grants-in-aid have been received from industries for the development of desirable projects by the Association, projects for the improvement of science teaching and materials. Conferences with science teachers have been held in several cities for the purpose of evaluating and discussing those materials best suited to the teacher's needs for background information and classroom use. Conferences have been held with representatives of industries for the purpose of advising them concerning the type of materials suited to student and teacher use, and the kind of science information desired by teachers.

Out of such conferences can come a better understanding of the relation of science education to the preparation of the scientist who is to carry on the research of tomorrow. We believe an improved understanding can mean a better interpretation of science. It can establish a stronger base of informational experiences for students and teachers.

It can weld together the work of classroom research and industrial research, and thus become a mighty universal force in promoting those activities that can bring about a higher type of civilization. And, finally, it can mean if developed far enough, a greater emphasis on the constructive use of science as a means of helping civilization to progress. ●

*Participating: Society of the Plastics Industry, Inc., National Fertilizer Association, American Forestry Association, Forest Service U. S. Department of Agriculture, H. J. Heinz Company, Wheat Flour Institute, American Gas Association, Inc., and Firestone Tire and Rubber Company.

The Handicapped Child

(Continued from Page 122)

Weaving is another activity that we carry on, from the simple over-and-under method to the more advanced work of using two and four harness looms. Each child is given opportunity to progress at his rate of development. Weaving offers a wealth of possibilities for integration in a unit of study. There are times when the unit chosen does not offer such opportunities. In that case we continue the activity apart from the unit. Weaving justifies in many ways its place in the program for exceptional children. The large variety of tools and materials used in weaving lend themselves readily to adapting the work to pupil ability, ranging from the youngest and least capable up to and including the most advanced pupil. As in all special class instruction, the teacher should guard against continuing a child on any phase of weaving which he or she has learned to do successfully.

Summary

Activities that are largely manual are usually most helpful to the handicapped child.

The process of learning for the handicapped is the same as for the normal child.

In planning a unit of work the subject matter is arranged to fit the needs of each child.

In guiding any activity whether creative or directed, the teacher's goal is not necessarily a finished product. She is concerned rather with what it does to the child, the satisfaction and joy that comes to the child from the part he takes in the project.

Fitting education to the needs of the child and society is an ever challenging problem to the teacher of the handicapped. ●

Liberal Education and Science

• **By Laurence L. Quill. Ph.D.** *(University of Illinois)*
DEPARTMENT OF CHEMISTRY, MICHIGAN STATE COLLEGE, EAST LANSING, MICHIGAN

Most informed persons agree that everyone needs training in science as a part of the general education that fits a man well for living in the modern world. All would gain from knowing how to apply the methods of science to the solution of diverse problems. On the other hand, the training of the scientific specialist must be liberalized if he is to participate adequately in the economic, social, and political life of his community.

Here a well known scientist and educator discusses the liberal education of the scientist, and science training in the liberal education of the non-scientist.

In a slightly modified form this article appeared in the February, 1947, issue of "The Science Teacher."

●

To the layman it might seem that the study of the laboratory sciences in the high school is necessary only in the college preparatory course. However, the reverse is more strictly the case. The large majority of our high school graduates do not enter college. They should, however, obtain science experience in the secondary school as part of their general education.

Interwoven into current discussion regarding educational matters are thoughts concerning the provision of a broad foundation which will better prepare our youth to cope with personal, family, vocational, social and civic problems. This broad foundation must include a study of man's relationship to his physical, biological, and social environment, and a knowledge of the development of our modern civilization.

Science means a variety of things to different people. Some think only of the glamor resulting from outstanding discoveries, while to others it means development of precise methods of observation and their logical interpretation. Science attempts to understand nature, to analyze and appraise facts. Science is not technology. Yet the two develop in parallel because the former furnishes the "know-how and why" so essential to the latter.

Man as a social being, living in this physical world with its technological advances, needs scientific training in his educational program.

Science plays a dual role in the educational process: (1) the liberal education of the scientist and, (2) science training in the liberal education of the non-scientist.

Scientists increasingly are realizing the importance of a liberal education program for the prospective scientist. We who plan with these particular students should urge them to broaden their program of study, (1) so that they may become aware of the current social, economic, and political problems, (2) so that they may gain sufficient historical background regarding the development of civilization, (3) so that they may understand the methods used for the solution of problems in the past, and their influence on the development of current situations, and (4) so that they may recognize their responsibility for contributing to the solution of social problems. The scientist can no longer ignore the economic, social, and political community which surrounds him, and he must be prepared to act as a participating member of this community.

Courses provided in the general education curriculum for the potential scientist should not be superficially encyclopedic in nature, but should stress the basic concepts underlying a social philosophy.

The science instructor on the other hand, has a vital obligation in supporting the liberal education program of the non-scientist. He must cooperate so that this program will include the scientific fundamentals essential for the layman. He must endow the non-scientist with the philosophy and methods of science to an extent which will bring about the habitual use of the scientific method for the solution of problems in other fields of endeavor. I am sure that no man will question the desirability of habitually formulating a clear statement of a problem, the desirability of unbiased investigation and study of observed facts, and the desirability of continued openmindedness acquired from experimental procedure. To achieve this purpose, so essential for the student, it will be better to study thoroughly a few problems, carefully selected, than to have "filled in all the blanks" of a laboratory manual without having given a thought to the philosophy and methods of science.

The science teacher has an obligation, as L. W. Taylor of Oberlin has expressed it, to show that the "practical aspects of the sciences are not to be despised, that their significance lies not so much in the multiplicity of inventions which makes the world so different and life so much safer and easier than it was a century ago, as in the subtle conception of Man's confidence in his intellectual supremacy over nature."

Tomorrow's science will provide the foundation, the strength for a peaceful world. Tomorrow's scientists need a liberal education and the maximum opportunity through good teaching, with modern equipment, and most of all through inspiring leaders to become the leaders in their chosen scientific fields.

But it is just as essential that the layman be able to apply the methods of science to the solution of his

(Continued on Page 134)

What is the *Rh* Blood Factor?

• **By Gladys M. Steffan**
JUNIOR STUDENT, MARYGROVE COLLEGE, DETROIT, MICHIGAN

The writer of this paper became interested in this topic when she was doing volunteer service in the chemistry laboratory of Children's Hospital, Detroit.

Although the exact nature of the Factor is not yet known, physicians have studied its reactions and have found a treatment for the dangerous children's disease for which it is responsible.

From time to time The Science Counselor is glad to present a student paper that shows evidence of careful study.

●

The discovery of Rh has aroused more public interest than any other recent medical success. For, when researchers reported in 1941 that they had discovered a new blood factor, that it causes a dangerous children's disease, and that the majority of the population possesses it, parents began to worry. If most people have the factor that causes *erythroblastosis fetalis*, this killing, crippling children's disease might strike any home. As a result, more than one disturbed mother has asked her physician, "Exactly what is the Rh factor?"

Science can answer only that it is something in the blood. We do not know its composition nor do we know its beneficial effects, if any. But at least we are certain of its existence. Its unvarying reaction in the laboratory, in transfusions, and in cases of erythroblastosis fetalis have proved that beyond a doubt; and physicians equipped with the basic facts of the existence of Rh and of its reactions, have found a treatment that will save babies who five years ago would have had little chance for life.

This new hope for parents and babies has stemmed from the discovery of two physicians, Landsteiner and Wiener. In 1941, they injected blood from a rhesus monkey into a rabbit. They hoped to develop in the blood of the rabbit a serum which would react with some unknown human factor. The basis of their experiment lay in the fact that when any foreign microörganism enters an animal's blood, the tissues of that animal tend to develop antibodies which destroy the foreign substance, and the animal acquires immunity since the antibodies either remain a long time or the animal becomes so sensitized that his tissues can readily manufacture more.

The blood of every animal contains certain proteins and chemical substances which vary in different individuals and which act like foreign substances when the blood of one animal is injected into the veins of another. For this reason, Drs. Landsteiner and Wiener hoped that in the tissues of the rabbit, an antibody would be developed which would destroy the foreign substances of the monkey blood and that this antibody would also destroy some unknown factor in human blood. This latter hope was not unfounded, for since the blood of the rhesus monkey is quite closely related to human blood, some unknown factor might be common to both.

The experiments did prove a common factor. After the rabbits were immunized blood was taken from them, and when this blood in turn was added to new monkey blood it agglutinized or dissolved the red blood cells. The conclusive part of this experiment was reached when immunized rabbit serum was added to human blood. The human red blood cells were destroyed just as the monkey blood had been. This phenomenon indicated the presence of a new factor which was named Rh. Not all types of human blood were destroyed by the rabbit antibodies; consequently the researchers designated that blood which had the factor, *Rh positive*, and that which did not have it, *Rh negative*.

Further investigation has shown that about 15 per cent of the white race are Rh negative, while the remaining 85 per cent are Rh positive.[1] When blood was taken from an Rh positive person and injected into the negative type, the reaction was the same as it had been in the laboratory. The tissues of the Rh negative person built up antibodies which destroyed the positive blood cells. This tissue reaction gave the research workers their first realization of the importance of this factor, for if a man who needed a transfusion were negative and the blood given him were positive, his body would destroy the new blood and not only would he fail to receive any benefit, but his body would also be exhausted by the battle of antibodies.

Even more important than the significance of Rh in transfusions was the suspicious similarity of Rh reactions to those found in children suffering from erythroblastosis fetalis. The victims of this disease suffer anemia and are sometimes jaundiced. Their red blood count is abnormally low. Their tissues are swollen from the collection of fluids in the tissues and their blood is partially or completely destroyed and replaced by a greenish-yellow substance. Investigation proved that 91 per cent of the mothers of such children are Rh negative, while their husbands and children are almost 100 per cent Rh positive.[2] Investigators concluded that blood from the Rh positive child gets into the mother's bloodstream through a damaged placenta* and the tissues of the mother produce antibodies which destroy the factor in her blood. The tragedy occurs when these

*The placenta is the organ by which the fetus is nourished, consisting of an arrangement of vessels by which the fetal blood and the maternal blood are brought into close proximity. It does not, however, effect an interchange of maternal and fetal blood.

agglutinins return to the child and begin to destroy his red blood cells. It was obvious, then, that at least 91 per cent of the disease is caused by the Rh factor.[2]

However, 9 per cent of these women are not Rh negative; hence they could not produce the Rh antibodies. Scientists believe that there must be other blood factors, as yet unknown, which explain the disease in the children of this 9 per cent.

While 13 per cent of white couples are in danger of having erythroblastotic children, only about 4 per cent actually do.[5] There are several reasons for this. The baby's blood may not go into the mother's circulation, for it can go only through a defective placenta. Then, a mother may not be capable of producing antibodies since not all humans can. Because antibodies seem to develop slowly in some women, the first, and even the second-born infant may escape. Thus, the disease may not appear in a small family. Moreover, since the Rh factor is hereditary,[6] the recessive Rh negative gene may be carried in the Rh positive father so that only one or two of four children may be Rh positive and only part of the family would be afflicted.

For those families in which the disease does appear, the real importance of the discovery of Rh lies in the correct treatment. Although medical scientists realized before its discovery that the blood of erythroblastotic children was destroyed and must be replaced, they knew nothing of the cause of the destruction. Therefore, the new blood given the babies in transfusions was usually Rh positive, and as such was quickly destroyed by the child's antibodies. In one striking case, knowledge of Rh came in time to save the mother's life but too late to help her child. The mother had just delivered her third baby. She needed a transfusion because of a hemorrhage, but when her husband's blood was used, a severe reaction set in. Fortunately her physician, knowing of the new factor, made special blood tests which showed that the woman was Rh negative while both her baby and her husband were Rh positive. These tests also showed that some Rh antibodies were present in both the mother's and child's bloodstream. The baby's red blood cells had already begun to dissolve and, because knowledge of treatment had come not quite soon enough, he died twelve hours after birth. The mother was also failing when Rh negative donors were found. After five transfusions, she began to recover.[5] This case vividly demonstrates the increasing surety and skill which research gives to physicians. Now, for both babies and their mothers only Rh negative donors are used, and while it is impossible to compare the present mortality rate with that previous to the discovery of Rh since many cases were not recognized at that time, almost every child who would have died under treatment of Rh positive blood today recovers, through proper blood transfusions.

From treatment, physicians are carrying their research on to possible prevention. One theory, presented by Dr. Lyman Burnham at a meeting of the New York State Medical Society,[9] holds that an increase of vitamin C for prospective mothers may prevent some cases. This conclusion is drawn from the fact that the mixing of the blood of mother and child occurs from a break in the blood vessels of the developing child. The capillary blood vessels are known to be fragile and likely to rupture if there is a vitamin C deficiency. Tests have proven that in normal pregnancies the amount of vitamin C in the blood plasma is only about one-third the usual amount, and in twelve out of thirteen mothers of erythroblastotic children there was a definite vitamin C deficiency.

With this information physicians may be able to find preventives for erythroblastosis fetalis, thus completing the story of Rh in which science played its best role, exploring, discovering and re-exploring every new bit of knowledge, always striving to make ours a healthier world. In this case, the hundreds of babies who owe their lives to the discovery of Rh, are ample testimony to its success. ●

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★ ★ ★ ★ ★

"The teacher needs only to remember that he is neither deity nor engine; he is a man and in proportion as he succeeds at his calling he will be surrounded by more men. He and they are society.

Mark Van Doren
Liberal Education

★ ★ ★ ★ ★

Oxygen and Industry

(Continued from Page 106)

oxygen of the highest purity, the type of unit developed in this country during the war produces high-purity oxygen. The production capacity of low-pressure units may, however, increase as much as 25 per cent as the purity of oxygen decreases from 99.6 to 98.7 per cent

A new familiarity of engineers with oxygen production, combined with wartime technical advances, has brought closer to reality many tonnage uses of oxygen which were only speculations before the war. Since, with few exceptions, oxygen has never before been used on the scale and for the purposes now considered, the new uses will have a significant effect on industry. The price at which the oxygen can be produced is, of course, the determining factor for all the projected large-scale uses. By reducing the costs of production, the new developments promise to broaden the use of oxygen in the customary applications and to permit its large-scale use as a processing chemical.

The large-tonnage uses which are now just beginning to emerge from the experimental or development stage include: production of carbon-monoxide—hydrogen mixtures from natural gas or coal in the synthesis of gasoline, other liquid fuels, and oxygenated chemicals; acceleration of the melting of scrap in the open hearth for increased production of steel; enrichment of air in the iron blast-furnace, and generation of gas.

The manufacture of synthetic gasoline is rapidly nearing commercial application in this country. Although the methods, variously designated as the Synthol, Synthene, or Hydrocol process, are derived from the German Fischer-Tropsch process, the Germans themselves did not utilize it to any great extent during the war. Research and development work in this country since 1938 resulted in tremendous improvements in technology, with increased efficiency, decreased investment costs, improvement of the quality of the hydrocarbon products, and production of substantial volumes of a large variety of oxygenated chemicals. An engineering feature introduced in this country is the application of the so-called fluidized technique, wherein a bed of finely divided solid catalyst is maintained in a turbulent state. Two plants now at the engineering stage will employ oxygen rather than steam for converting methane under conditions of partial combustion to a gas having the desired percentage composition of carbon monoxide and hydrogen for the reaction:

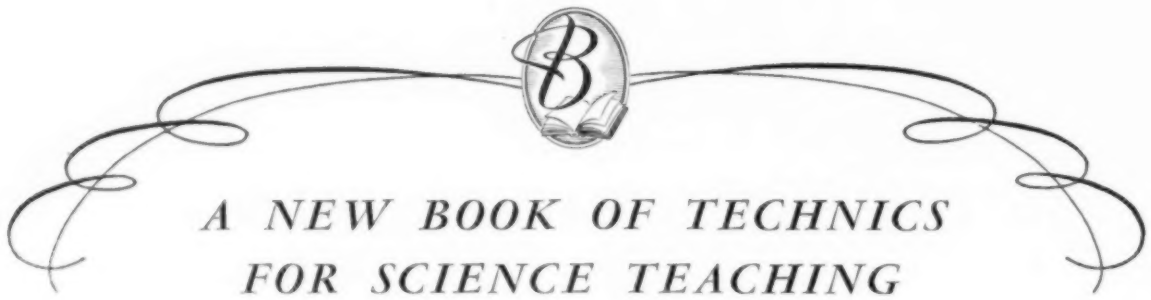
$$8\,CH_4 + 4\,O_2 \longrightarrow 8\,CO + 16\,H_2.$$

In the open-hearth process of steel making, economies have been effected by the use of oxygen in the flame during the charging and the melting down period of the "heat", or by introducing oxygen into the molten metal in order to reduce the carbon content. Large-scale tests have been carried out by several of the large steel companies during recent months with reported savings of as much as four hours when melting a charge of approximately 400,000 pounds. Industry-wide adoption of the use of oxygen in open-hearth practice would mean an investment in the near future of up to 200 millions of dollars.

The iron blast-furnace can be rated as one of the most important units in our industrial economy. With over 200 units capable of producing 66 million tons annually, the United States today has over 50 per cent of the pig-iron producing capacity of the world, yet demand is still beyond the maximum which can be produced. One of the means suggested for increasing production is enriching with oxygen the blast entering the furnace. At present, the benefits must be calculated from rather inadequate data on European tests, but large-scale tests now planned for at least one furnace in this country should decide the issue. When this possibility is considered in combination with the rather certain large-scale use of oxygen in open-hearth practice, and the present substantial demands for oxygen in a steel plant, it seems probable that large plants to generate oxygen will shortly be as essential for the most efficient over-all operation of a steel plant as are the present utility facilities.

Cheap oxygen also promises to play an important role in the production of water-gas and producer-gas. In the traditional water-gas process, steam is made to react with incandescent carbon in an operation where a mass of coal or coke is alternately blown with air and then with steam. "Blue" water-gas, a mixture of hydrogen and carbon monoxide, results. This gas is enriched to "city gas" heating-value standards by having petroleum oils cracked into it in the carburetor portion of the water-gas set. Producer-gas, largely for industrial use, is made by continuously blasting a deep hot bed of coal or coke with a mixture of air and steam. The nitrogen introduced as air dilutes the product gas. Operation of a process based on the producer-type reactions using oxygen instead of air could result in the continuous complete gasification of the coal without the presence of diluent nitrogen. "Synthesis gas" thus produced from coal may be converted into liquid fuels. Combination with a second step wherein a portion of the hydrogen and carbon monoxide is reacted to form methane may produce a gas with a heating value high enough to permit gasification of the coal at the mines, with transportation of the gas to consumption points via pipeline.

Other new developments utilizing substantial quantities of oxygen are for secondary fuel in rocket motors, for increased use in old applications through new techniques, and for fusion piercing of ore beds—a new method by which rock is melted to make vertical holes for explosives. This method may be of the greatest importance in opening secondary ore reserves. ●



A NEW BOOK OF TECHNICS FOR SCIENCE TEACHING

HOFF

Secondary-School Science Teaching

By ARTHUR G. HOFF, Ph.D., Associate Professor of Education, University of Redlands, California. With Study Questions, Problems and Projects, Bibliographies, Model Tests, Appendix. 325 Pages $3.75 (1947)

"Helping the science teacher to teach" is truly the essence of this new book by Dr. Hoff. Educational values are appraised as practical, disciplinary and cultural and. since the student lives in a predominantly science environment today, the book shows how to prepare him to adapt himself and make intelligent use of the facts and materials of modern science.

A clear and definite plan for Unit teaching is presented in which the various problems encountered in the science classroom are treated. Unit 1 discusses the mission of science in education; 2 the content of science in the secondary-school, 3 the function of method in science teaching, 4 specific technics in teaching science, 5 supplementary factors in science teaching. The unit plan permits the integrative use of other methods of teaching as a whole or in part whenever appropriate. These methods also are briefly described and their technics evaluated as applied to the teaching of science.

Dr. Hoff has devoted many years to science teaching in the junior and senior high school and in the area of training science teachers for the public secondary school. His book presents an up to date summary of functional information as determined by rich experience and research. It will help the beginning teacher master to a functional degree one method of teaching which will carry him through until experience and further study enable him to develop improved technics.

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NEW BOOKS

Secondary-School Science Teaching

• *By* ARTHUR G. HOFF, University of Redlands. Philadelphia: The Blakiston Co. 1947. Pp. xi + 303. $3.75.

No book can make a good teacher out of a poor one, but any teacher can become more successful by studying and putting into practice Dr. Hoff's ideas on how to teach science in junior and senior high schools. Some of his suggestions will be helpful to college instructors as well. His broad experience in teaching high school science and in training science teachers is evident throughout the book. He uses a common sense approach. Few will criticize the plan of having student teachers master one method of teaching instead of scattering their efforts trying to learn several methods.

Unit 1 considers the educational values of science and the teacher's responsibilities. Unit 2 studies the content of science in the secondary school. Unit 3 discusses the function of method in teaching. Units 4 and 5 consider specific techniques and supplementary factors such as science clubs, teaching aids, etc. Sample tests are included and specimen teaching units outlined. There are many references for reading, as well as study questions, problems and projects.

This book belongs on every science teacher's desk.

H.C.M.

Colloid Science

• *A symposium.* Brooklyn, N. Y.: Chemical Publishing Co. Inc. 1947. x + 208 pp. $6.00.

The knowledge of the physical and chemical phenomena that take place at interfacial surfaces is embraced by the branch of the natural sciences known as colloid science. This is a border-line field where the sciences of physics and chemistry overlap, but its importance reaches into many other fields, particularly that of the biological sciences. As a matter of fact, it is impossible for some of the problems of biology and medicine to progress toward a solution unless the men and women working on them have the necessary background of colloid science. Inspection of this volume should convince anyone who doubts this observation.

The small book under discussion is a result of a symposium sponsored by the Cambridge University of England. Ten short but excellent articles review the advances in the theory and applications of colloid science and offer the advanced student not only stimulating discussions but also generous literature references for further study. Phases and phase changes in monolayers, multilayers, emulsion stability, adsorbed films at the solid-liquid interface, electrical double layer, structure of micelles, electrophoresis, fat metabolism, membrane equilibrium, identification of bonds and structural units by infra-red spectra are among the important topics discussed in this volume.

The book has been edited and published with great care, and the only regret is that the relatively high cost will prevent its appearance on the library shelves of many graduate students.

Harry H. Szmant
Department of Chemistry
Duquesne University

Handbook of Chemistry

• *By* NORBERT A. LANGE, Compiler and Editor. Sixth Edition. Sandusky, Ohio: Handbook Publishers, Inc. 1946. Pp. xvi + 2064. $7.00.

Professional chemists as well as students of chemistry will be glad to have available for quick reference the time-saving collection of data found in this well known book. Physicists, biologists, geologists, and workers in other scientific fields will use it freely.

The sixth edition has gained in value through a careful revision of the tables found in previous editions, the addition of several new ones, and the elimination of a few that pertained more especially to chemical engineering. The table of physical constants of inorganic compounds has been enlarged and rewritten. The new subject matter includes among other things tables of ionization constants of acids and bases, critical constants of gases, and a discussion of modern concepts of matter. The mathematical appendix by Richard S. Burrington, which is also published as a separate volume, is reviewed elsewhere in this number.

H.C.M.

Handbook of Mathematical Tables and Formulas

• *By* RICHARD STEVENS BURRINGTON. 2nd. Edition. Sandusky, Ohio: Handbook Publishers, Inc. 1947. Pp. 275.

This set of tables is well arranged and printed in clear easy-to-read type. The author is to be commended for including in addition to the usual tables very useful diagrams of curves and three dimensional figures in the section on analytical geometry. There are other useful features not often found in tables such as the inclusion of relations among inverse functions, an extensive table of derivatives, and a section on vector analysis. Perhaps the only regrettable feature is that the table of integrals is not somewhat more extensive. On the whole this is an excellent set of tables that will be useful for students in colleges and for industrial workers.

M. Ostrofsky
Head, Department of Mathematics
Duquesne University

Air Conditioning

• *By* HERBERT HERKIMER AND HAROLD HERKIMER. Brooklyn: Chemical Publishing Co., Inc. 1947. Pp. IX + 692. $12.00.

This book gives workers in the field up-to-date information on all phases of air conditioning. It also offers valuable background information to persons who have a general interest in this modern and progressive industry which leans so heavily on science.

Early chapters are devoted to a not too elementary consideration of the basic physical and chemical principles upon which the industry is based. Then come their practical applications. Chapters on elements of health and comfort, air conditioning equipment, humidification, drying, cooling, automatic controls, and industrial applications lead to a final chapter which discusses the estimating of costs.

The authors are a father and son team. The father has had some 35 years' experience in the air conditioning industry.

H.C.M.

The Freezing Preservation of Foods

• *By* DONALD K. TRESSLER AND CLIFFORD F. EVERS. 2nd Edition. New York: Avi Publishing Co. 1947. Pp. XVIII + 932. $10.00.

Within the last decade quick freezing has become one of the most useful methods of preserving foods, both commercially and on a domestic scale. Six billion pounds of food are treated annually. This important book contains information that will interest and inform the home worker and more especially the commercial freezer.

The authors write from first-hand knowledge. Mr. Evers is technical director of the National Association of Frozen Food Packers, Washington, D.C. Dr. Tressler was formerly head of the division of chemistry at the New York State Agricultural Experiment Station at Geneva. Both have been connected with nationally known frozen-food packers.

After a discussion of the principles of refrigeration and quick freezing systems, the preparation of foods for freezing is studied,—vegetables, fruits, meats, poultry, fish, etc. There are chapters on pre-cooked frozen foods, the cooking and serving of frozen foods, and their storage, transportation and marketing. There are 200 line drawings, charts and photographs. Each chapter has a useful bibliography.

H.C.M.

The Alchemist

(Continued from Page 117)

The assistant portrayed in the rear of this picture is typical of Teniers, whose style van Heemskerk was said to have followed. The alchemist and his surroundings are, however, quite original with van Heemskerk and set forth the painter's skill in arrangement and ability to draw and paint.

Note the manner in which the light from the window strikingly illuminates the globe and the various chemical jars, also the one spot of brilliant color—the alchemist's hat. The four transparent glass utensils on the floor look like the actual articles.

Seven Subjects Reproduced

Seven subjects from the Collection have now been reproduced, three in full color and four in black-and-white. They have filled the need among scientists for appropriate pictures so well that literally thousands of them are now hanging in laboratories, offices of directors of research, libraries, etc. They have been made available at the actual cost of printing and framing as a service to American Science.

The pictures shown with this article are the three which have been reproduced in full color. •

Liberal Education and Science

(Continued from Page 128)

diverse problems, and that he have a background for the wise interpretation of the developments of science.

We have reflected here ideas from only a few of the many facts about the interrelationship of science and a liberal education. We will close by quoting Professor Carlson of the University of Chicago:

> "Science has indeed disturbed the traditional humanities, not so much by crowding the curriculum as by questioning ancient and easy answers and interpretations. Science bows to no man, not even to the "hundred great books" of the past. Yes, science is an iconoclast, a disturber of faiths and dreams, a challenger of nostalgia. But science is a product of man, and science changes significant parts of man's environment faster than does raw nature. Science creates new problems important in the lives of all the people. The science core in liberal education must provide an understanding of these changes and problems lest we perish." •

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QUOTES

"Having the student acquire ready-made answers to problems from someone else is not equivalent to having him discover and appraise his own answers."

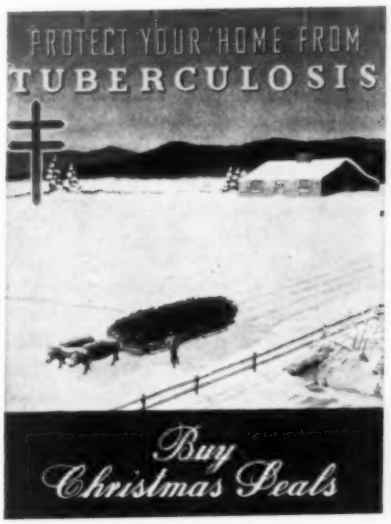
Edward F. Potthoff
Journal of Higher Education
October, 1946

"Fortunately there is a resiliency of the human spirit that breaks forth after mental depression like the burgeoning of spring. Courage and optimism and confidence in goodness will doubtless return to many of those who lost these qualities during the war. The rising generation has them, possibly to an unusual degree. Clearly one of the most urgent tasks of educators and scientists is to bring about a moral regeneration in this country. Such a high purpose is consistent with the exacting principles and ideals of science."

F. R. Moulton
AAAS Bulletin
September, 1946

"Most textbooks, and most instruction based upon these, seem designed to encourage the student to lay hold of the knowledge and opinions they contain rather than to explore the sources of that knowledge, the validity of those opinions, and the vast reaches of fact and theory that lie beyond the textbook boundaries. It's probably a general rule that the majority of students finish courses without having learned how what they have learned came to be known in the first place."

Wendell Johnson
State University of Iowa
The Journal of General Education
Vol. 1, No. 3, April, 1947



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Chromatography

(Continued from Page 109)

A very simple experiment which employs the chromatographic technique of developing a chromatogram with a flowing liquid can be carried out as follows. Place a piece of filter paper between two pieces of dry glass (lantern slide cover glasses work very well) and trim off the filter paper along one side where it projects beyond the glass. This gives a straight edge of filter paper several inches long. Hold this filter paper sandwich vertical, with the cut edge at the top and horizontal, and let a very small drop of the black ink (the one mentioned above) soak into the paper half-way along the trimmed edge. This forms a semicircular black zone. The chromatogram is now developed by allowing water to dribble into the paper at the center of the zone from a medicine dropper. A brilliant chromatogram develops, though it may be somewhat irregular in outline. The function of the glass is to contain the water and prevent evaporation from the flat surfaces of the filter paper (the adsorbent). If no glass is available a chromatogram may sometimes be obtained by putting the drop of black ink (or other mixture to be separated) in the center of a piece of white blotting paper, and then allowing water to flow slowly into the center of the spot from a dropper. The chromatogram is developed by the water as it flows out through the capillary spaces in the paper. The chromatogram may be more brilliant on the under side of the blotting paper. Pieces of zone can be cut out from the paper and examined by spot-tests with acid, etc.

The principles upon which the chromatographic method operates may be summarized as follows. Molecules in a mixture are allowed to distribute themselves between a solution and a surface. The available surface area is made extremely large by using a very finely divided, or very porous, adsorbent, thus large numbers of molecules can be accommodated. The molecules of one kind compete for the available surface with those of the other kinds, the more strongly adsorbed ones being adsorbed in relatively greater amount. The differences in adsorbability are utilized by arranging the adsorbent so that as fresh liquid is passed over the adsorbed mixture the more weakly adsorbed material is carried away from the more strongly adsorbed. Complete separation of the components of the mixture may then result.

As was pointed out above many other separation processes employ the same principles but apply them to different partition processes.[3] For example, in fractional distillations employing reflux the mixture to be separated is boiled and the vapors passed up a fractionating column at the top of which some of the vapors are condensed and allowed to flow back down the column. The returning liquid, flowing back in contact with the ascending vapor washes it, removing the less volatile components and allowing only the more volatile to pass. The partition process used here is distribution of the molecules between liquid and vapor phases, and the separation is made more complete by flowing the one phase in an opposite direction to the other. Mixtures can be separated in an analogous manner by using two immiscible liquids (such as ether and water) and allowing the molecules to be separated to distribute themselves between the two liquid phases. The separation can then be made efficient by flowing the liquids one counter to the other (the heavier water down through the ether) with good stirring.

The chromatographic method for separating mixtures has been described in a very general way. It should be pointed out, in closing, that many subtle refinements of the method have been worked out. The fact that books have been written on the subject suggests that the matter is more complicated than has been indicated. Enough has perhaps been said, however, to indicate general principles. It should never be forgotten that methods of analysis are at the basis of scientific advance, and that although we have many excellent methods already there is always need for better ones, and the development of better generates need for still better. Perhaps some of the readers of this article will have the ingenuity to devise and the patience to perfect some new and better method of separating mixtures of molecules. ●

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★ ★ ★ ★ ★

"The fact is that the unit of scientific research is a *scientist* with a group of assistants and he is, by definition, capable of directing his own work by his own methods. In the operation of his work, he must be independent of all control and free to do whatever he wishes."

C. E. Kenneth Mees
The Path of Science

★

"If the ideas and the ends of the scientist are understood by the people, the growth of knowledge can bring only its classic benefits. If science withdraws, remains narrow and special, fails to see its place in society, teaches only its devotees, the growth of knowledge will threaten us all. With danger to men there is danger to science itself. For science is but one of the rich activities of men."

Philip Morrison
Cornell University
Journal of Higher Education
April, 1947

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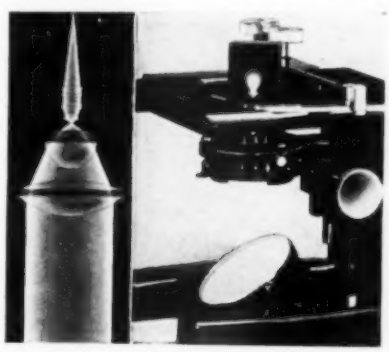

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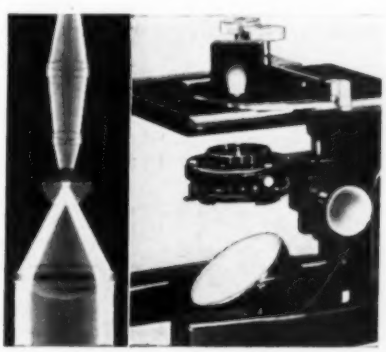
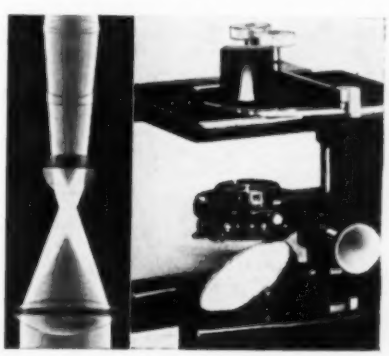


Upper and lower lenses of the B&L Variable Focus Condenser separated widely to focus illumination for the 28 mm objective. Light rays are nearly parallel and field greatly enlarged.



Synthetic Detergents

(Continued from Page 114)

(3) Sodium alkyl sulfonates:
MP189

(4) Sodium dialkyl monosulfosuccinates and alkyl sulfoacetates:
Aerosol OT, Nacconol LAL

(5) Sodium salt of sulfated and sulfonated amides:
Igepon T

(6) Sulfated and sulfonated oils and their sodium salts:
Turkey red oil

(7) Cation-active compounds including alkyl pyridinium chlorides and quaternary ammonium salts such as benzyl trialkonium chlorides: Ceepryn, Roccal, Zephiran

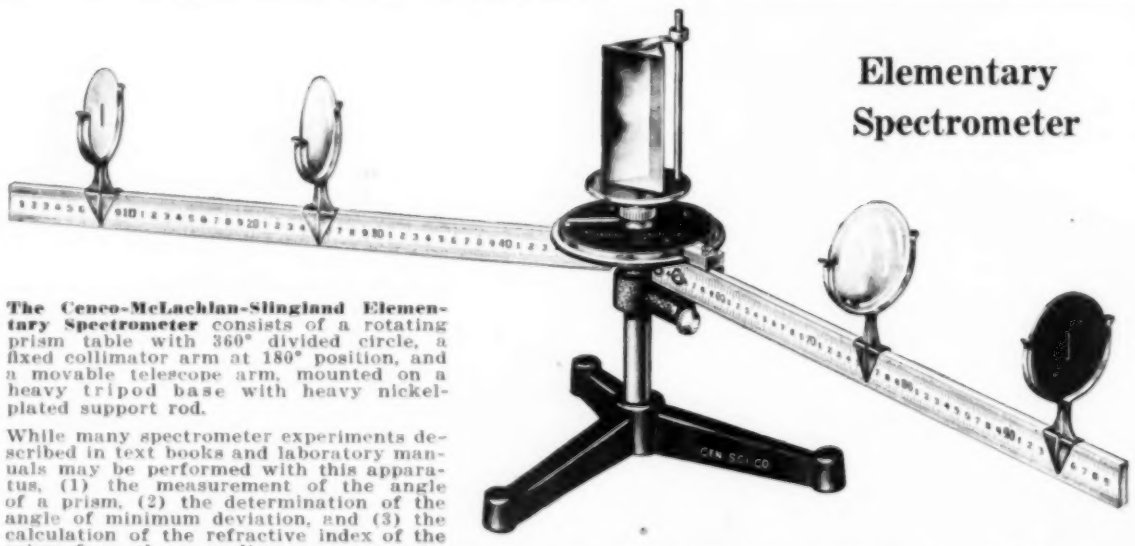
(8) Nonionic compounds such as complex fatty-acid amides, complex ethers, and partial esters of polyhydric alcohols:
Santomerse DT, Triton NE, Spans, Tweens, Pergal 0.

The alkyl aryl sulfonates are the most important commercially of the synthetic detergents, as represented by some of the Nacconol and Santomerse products. More than twice as much of this type is produced as of any other class.

For maximum effectiveness as a detergent, the total chain length of a straight-chain hydrocarbon should be about $C_{14}-C_{16}$. When the benzene group is introduced to make an alkyl aryl sulfonate, this has been found to be approximately equivalent to a C_4 straight chain. This explains the desired C_{12} alkyl group in the alkyl aryl sulfonates.

The alkyl aryl sulfonates are used mostly as general detergents. They are particularly useful in hard-water areas to replace soap, and in acid solution in certain industrial processes. They are compounded in varying proportions with alkaline salts to give numerous branded household cleaners. The alkyl aryl sulfonates are particularly good for washing wool. They are not as effective on cotton, that is, the detergent action is very slow.

Next in importance to the alkyl aryl sulfonates are the alkyl sulfates, which were the first synthetic detergents to become commercially successful on a large scale, typified by the Duponols and Gardinols. The structure is closely related to that of soap, but the water-attracting group in soap, $-COONa$, has been replaced by $-OSO_3Na$, while the hydrocarbon radical is essentially the same in both. In fact, the raw materials are the same as for soap, namely, saponifiable oils. Coconut oil is the one most used, as it gives a mixture



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with a desirable average chain length, often referred to as lauryl or dodecyl.

Alkyl sulfates are excellent hard-water detergents, even better than the alkyl aryl sulfonates. Since the compound is an ester, the alkyl sulfate is less stable in strongly acid solutions than the alkyl aryl sulfonate; the alkyl sulfate is also less stable in hot water, although not sufficiently so for this to be a detrimental factor in laundering. The alkyl sulfates make excellent hard-water detergents and in the textile industry are especially good for scouring raw wool.

The other anion-active agents listed are much less important commercially.

Cation-active agents are the opposite of the more common anion-active agents. Their most important function is as an extremely powerful antiseptic, so that use is mostly where bactericidal action is needed. Although several times as expensive per pound as coal-tar disinfectants, their potency as bactericides has created a place for them in sanitation. In addition to having a very high phenol coefficient they are nonirritating to the skin, noncorrosive, and nontoxic. They can therefore be used much more freely than cresols and phenol.

For example, important applications are in detergents for use in mechanical dishwashing, for sanitizing eating utensils and glassware in restaurants and bars, and as a detergent and sterilizing agent in many food-processing industries, including fisheries, bakeries, etc. They cannot be used admixed with soap or other anion-active detergent, since the two large radicals of opposite charge precipitate each other, so that activity of both types of agents is lost. During the war the cation-active agents proved extremely useful for cold sterilization of surgical instruments, and to surgeons on the field for prewashing or scrubbing up before operating.

During the war millions of man hours were saved by application of surface-activity. To illustrate with an example from the Delco plant of General Motors: They were making undercarriage parts for bombers. The parts were machined, spray cleaned with an alkaline cleaner, dried, coated lightly with oil and shipped. At the other end they were unpacked, cleaned, dried, and put on the assembly line. Here is what surface-activity did. The original cleaner was changed to an emulsion cleaner from which the metal parts sorbed a protective layer of oil only a few molecules thick due to preferential wetting. The cleaned parts were just packed with no further coating or drying and no cleaning at the other end. They would not rust in less than 30 days.

How do synthetics compare with soap? Experience shows that in distilled water soap is by far the most surface-active of any of the agents which we have studied. A great deal of research continues in many laboratories throughout the country in the effort to modify the existing surface-active agents, either in structure or by blending materials, so as to approach more closely in hard water the performance of soap in soft water. We still need to learn more about the underlying theory of these complex compounds. What is the real secret of detergent ability? Why is soap so superior as a detergent under favorable conditions? I feel sure that many improvements will be made in the development of synthetic detergents, so that cleaning processes will be made easier in time to come. ●

★ ★ ★ ★ ★

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Sugar

(Continued from Page 112)

way as calcium gluconate. The phenylhydrazone of the acid has been used to some extent in medicine. Levulinic acid has also been reported to have some action as a plant growth hormone. As an intermediate for the synthesis of heterocyclic compounds, it shows promise for future applications.

By the action of metallic oxides and ammonia, sugar is transformed into hydroxymethylimidazole which may serve as an intermediate in the synthesis of histidine and histamine. Histidine is one of the amino acids essential for life and finds application in medical practice for the treatment of stomach ulcers. Histamine is a powerful drug with a number of marked physiological effects.

By combination with allyl chloride, sugar forms allyl sucrose, a viscous liquid which when exposed to air in a thin layer polymerizes to a hard transparent film with excellent heat and solvent resistance. It is expected that allyl sucrose may find applications in the coatings field.

The action of oxygen upon inverted sugar in the presence of alkalies produces salts of arabonic acid, an intermediate in the synthesis of ribose, which in turn enters into the synthesis of vitamin B_2 or riboflavin.

Hydrogenation of sucrose yields mannitol and sorbitol, which are both finding extensive industrial use in explosives, emulsifying agents, softeners, humectants and drugs. Sorbitol is also the starting material for the synthetic production of vitamin C.

Interaction of sugar with acetic anhydride produces a remarkable change in properties for the product, sucrose octaacetate, is insoluble in water and intensely bitter in taste. It is used as a stomachic in minute quantities and for denaturing alcohol as well as in the role of a plasticizer.

By-products

The by-products of sugar manufacture from cane and beets also deserve mention. Research is concentrating on applications for bagasse, the cellulose pulp remaining after sugar juices have been removed. Among the most promising developments are more extensive use of bagasse in the manufacture of wall board, improved methods of making paper and box board pulp, and as a source of raw material for the manufacture of plastics. Certain varieties of cane have an appreciable amount of wax with properties very similar to carnauba wax of South America. Bagasse has the advantage that no collection problem is involved. It accumulates at raw sugar mills where often part of it is used as fuel.

The principal by-product of beet sugar manufacture is pulp, which mixed with molasses has always been valuable as animal fodder. Beet pulp also contains valuable amounts of pectin and research is currently working out methods of recovery. Glutamic acid, it appears, can also be profitably extracted.

At the University of Colorado a process for separating levulose, the sweeter half of the double molecule of common sugar, has been worked out. Currently, two hundred pounds of this substance are being turned out daily to provide experimental quantities for physiologists and food technicians. ●

East African Flora

(Continued from Page 124)

no tree for support hugged the ground for ten feet or more and then grew up into a fairly representative though peculiar looking tree. Its crown was about twenty feet above ground.

Other *Euphorbias* worthy of mention here have medicinal uses. The castor oil plant is grown almost anywhere, but in Africa seemingly it took considerable time for it to come into general use as a medicine, although the medicine men used it occasionally. During the war the European supply became so short that the Government broadcast information on how to treat the beans to obtain the oil. The people then prepared large quantities of it for their own use and for sale. Another Euphorbia, the croton oil plant, supplies a violent purgative. The people did not know it, but they took croton oil as a medicine at the local hospitals under the name *Dawa ya mkate*, "bread medicine", because they received it in doses of three or four drops on a piece of bread.

I regret that in these short notes I must omit such an important family as the *Compositae* and even a passing mention of East Africa's outstanding beauties like the glorious lily (Fig. 3), the wild gladiolus, and the fireball *(Haemanthus multiflorus)*. Some years ago in compiling a dictionary, a Holy Ghost Father appended a list of East African botanical specimens without notes of explanation. The list covered about 30 pages of fine print. To supply notes on such an extensive list would require a large volume. Naturally, I have made no attempt at completeness here.

In closing, I would like to describe, although unscientifically, a flower that interested me greatly. I have not been able to classify it. Better informed botanists may be able to supply its proper name. The plant is a creeper, growing in shady places. Occasionally it climbs a banana plant; so the Chaga people call it simply "the banana climber" (Kiserangida). Its heart-shaped leaves grow in opposite pairs. The flowers which measure an inch across are attached to a short stem. The five yellow two-lobed petals unite into an inch-long tube that is white outside and deep purple inside. There are four stamens attached to the inside of the tube. There is but a single pistil most of which remains on the ovary after fertilization. The seed pod is about the size and shape of a single pea and contains four seeds. Below the ovary there is a tiny calyx and two leaves that close up and cover the seed pod after the corolla disappears. Minor diseases of the eyes were treated with the juice expressed from the crushed leaves of the plant. It is pictured here (Fig. 6).

Can you identify it? ●

fathematics

(Continued from Page 110)

otional being. In doing this a liberal education will use the student's natural intelligence to follow in the otsteps of those intellectual virtues which are the inent merits of the real scientist or artist.[10]

Emancipation presupposes intelligence and implies e achievement of self government. Freedom is per- nal or not at all. It is achieved by those whose dignity serves it; it cannot be acquired without the discipline knowledge.[11]

Magnanimity is the loftiness of spirit which leads to ions and sacrifices that have a noble purpose. It is e ideal of liberal education whereby all arts and iences "conduce to one all-encompassing end, that of abling one to live abundantly through obeying the ghest law of man's nature as explained by our Lord, e Law of Love."[12]

Efficiency combined with intelligence, emancipation, nd magnanimity produces the supreme ideal of educa- n, namely, the possession of the foundations of *wis-* . In this respect liberal education agrees with So- tes: " . . . badness is a species of ignorance, the wise n the wise woman will be good."

Now if the natural sciences are to be the cultural expression of the objective side of human experience,[13] they must aim to guide the student "in the evolving dynamism through which he shapes himself as a human person—armed with knowledge, strength of judgment, and moral virtues. . . ."[14]

Those who hope to attain in the course of life to the spiritual status of a liberally educated mind may not neglect the disciplines of mathematics and science, for: "One of the great abiding facts of life and the world is the fact that we humans are completely immersed in an infinite universe of matter and force, of which we are literally parts, and in regard to which it is the functions of science to give us intelligence."[15]

If the courses in the division of natural science are taught not only for the sake of practical application, but essentially for the sake of knowledge, and in connection with their history, they furnish a vision of the universe, an understanding of scientific truth, and a sense of the sacred, exacting, unbending objectivity of the humblest truths which play an essential part in the liberation of the mind.[16]

That science does possess that loftiness of spirit known as magnanimity is the keynote of the address of Pope Pius XII to the members of the Pontifical Academy of Science, December 3, 1939, when he said:[17]

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Thus we conclude with Maritain that "natural science must be considered as one of the chief branches of liberal arts."[18] We add that the division of natural science, realizing and fulfilling its obligations, occupies a place in the liberal arts college comparable to that of the *Quadrivium* of medieval times. In this capacity it is as closely related to the humanities as was the *Quadrivium* with the *Trivium*. Hence the scientist and humanist together, "must stand in reverence and humility, deeply aware of man's imperfections and nature's mysteries, conscious of the never completely fulfilled need for sympathy, fraternity and labor in scholarship, enterprise and achievement."[19]

Aims of the Division of Natural Science

Members of the division of natural science in the liberal arts college, realizing the purpose and cherishing the ideals of such a college might do well to consider the following two-fold aim for their division.

1. To make the student conscious of the universe in which he lives, appreciative of the laws that govern it, mindful that Creation is the expression of God's love and that science has the privilege of cooperating in the diffusion of God's goodness.

2. To aid the student in her preparation for professional and research work.

Mathematics, an Art, a Science

It might seem that throughout the foregoing discussion mathematics has been given a place aloof from the sciences. Mathematics is "what may be called a mixed science."[20] Its study is for the student the "purest laboratory experience in the art of reasoning."[21] But despite its abstract character it is closely allied with the sciences which are mainly concerned with the mathematical reading of natural phenomena. We can realize this when we consider that the existence of the wireless telegraph is due to the deductions of Maxwell by means of theorems which depend upon the square root of a minus one, that the planet Neptune was discovered mathematically by Leverrier in France and Adams in England before any astronomer had noticed this wanderer in the remote heavens, that mathematicians employing the theory relative to finding the roots of an algebraic equation are able to tell the mineralogist that he will never find more than thirty-two distinct types of crystals. Other instances could be mentioned, but these are sufficient to indicate the reason for placing mathematics in the same division with the natural sciences.

In *The Philosophy of Mathematics*[22] James Byrnie Shaw states that the methods of mathematics are reducible to four, namely, (1) scientific, leading to generalization; (2) intuitive, leading to an insight in subtler depths (this is the method which enables mathematics to pass in the direction just opposite to that of logic, namely, from the particular to the general); (3) deductive, leading to permanent relation and rigorous form; (4) inventive, leading to the ideal element and creation of new realms.

The various courses in the mathematics department should employ these methods when they stress the theoretical aspects of mathematics in order "to aid the cultural development of the student by training her to express the results of rigorous and logical thinking in concise and accurate language" and when they present the important applications of mathematics to the scientific and engineering world.[23] These four methods should be considered when a program of courses is designed for the student majoring in mathematics, in order that her preparation for professional and research work will not be specialized. Considering these aims of the mathematics department, it might well be inferred that, in general, they are indirectly in accord with the aims of the division of natural science.

Thus in viewing the mixed role of mathematics and considering the many and various branches of this subject one is led to agree with Plato that "every art and science craves a share in them." Mathematics is indeed worthy "to occupy in the hierarchy of arts and sciences, the high place, to which, from the earliest times, the judgment of mankind has assigned it."[24] ●

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Advances in Physics

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short radio waves can be focused in a beam much like a searchlight.

A simple radar set sends out a short powerful pulse of high frequency radio waves, receives and times the echo from any object in its path. This information is translated into an image on the face of a cathode-ray tube or oscilloscope in the form of tiny spots of light. These spots are the reflections—converted electronically, out of invisible radio energy, into light—from whatever object was in the path of the radar's beam. Various types of images indicate direction, distance and height of the object which sends back the echo at the incredible speed of 186,000 miles per second. The radar echo from the moon on January 10, 1946 made the journey of 238,000 miles and back in 2.5 seconds.

However, radar means much more than a single piece of equipment. It is an intricate structure of vacuum tubes, transformers, electrical networks, rheostats, condensers and other circuit elements. On September 27, 1946, radar was used to observe the comet "Giacobini-Zinner," twenty-five million miles away, and on October 9, scientists using radar saw a brilliant display of meteors trailing this comet beyond fog and clouds. It may be of interest to know that a hundred forty-nine flashing projectiles were counted in a ten minute peak period by means of radar.

What then is the future of this two billion, seven hundred million dollar development? For the pilot, radar promises increased security as he flies through clouds, fog and darkness, confident that mountains, tall buildings or planes are not in his path. Radar promises safe landing no matter how dense the fog.

Our ocean shipping will use radar to avoid collisions with icebergs, rocks, floating wrecks and to enter harbors when weather conditions are unfavorable. Engineers of locomotives will be able to detect oncoming trains on the same track, or trouble ahead and will use the invisible eye of radar to give them visibility in storms, fogs or on moonless nights. Radar units in automobiles will make driving safe. Approaching hurricanes will be reported forty-eight hours in advance. Radar will be used to study the ionosphere and to detect enemy rockets beyond our atmosphere. Some day, presuming that transmitters, receivers and all kinds of electronic equipment are greatly refined, it might even be used to map the topography of the moon and the planets.

In this atomic, electronic era, yesterday's far fetched dreams hold the promise of fulfillment. Who can determine to what further analytical ability and experimental skill the Creator of the Universe will direct the scientific knowledge of the physicist? ●

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Research

(Continued from Page 120)

body needs. Many programs have been launched to assist housewives in planning menus to include vegetables, fruits, milk and other foods rich in minerals and vitamins, and to teach them the best methods of preparing and cooking foods to retain the greatest amount of their elements. A great deal has been accomplished by such programs but, since custom and habit determine to a large degree what foods will greet a family when they sit down to dinner, adult education at best reaches effectively only those families which are sufficiently interested to change their pattern of eating.

Education in school reaches the banker's son as well as the child whose widowed mother receives state aid. Children are the subjects with whom we must work if we are to attain a population wherein everyone enjoys optimum health. For educational programs in elementary schools colorful food charts are available with which to familiarize boys and girls with the foods they should include in each day's meals. Contests based on records of foods eaten at each meal by each child create competitive interest, and art classes offer opportunities for nutrition poster contests. Nutrition programs are extremely productive at higher levels of education also. For teen-agers, high school programs can combat excessive eating between meals, especially of sweets and soft drinks, the "coke and sandwich" lunch, dietary inadequacy in milk and vegetables, and insufficient rest at the time in life when increased nutritional demands are placed on the body by rapid growth and the physiological changes of puberty. Nutritional programs for teenagers, may utilize movies, slides, and talks by effective speakers, as well as classes in home economics, hygiene and family living. College students may be approached similarly, but on a more mature level. Enthusiasm aroused at school has an immediate influence on the family's dietary habits. School children can impress their parents with the bodily damage that can result from poor nutrition and change family eating habits as new foods become familiar to them. One of the most productive methods of nutrition education combined with a practical measure for improving nutritional status has been the school lunch program. Partial subsidy by the government assures the popularity of the school lunch and obtaining the subsidy requires serving nutritious food.

Teachers, perhaps more than any other professional group, are familiar with the tedious course of educational processes. At the same time they compose the group best able to appreciate that education is most productive and the results effective over the greatest time when applied to children. The results of nutrition research are not effective until they are applied. With the information gained by observation in classrooms and their knowledge of developments in various fields teachers occupy strategic positions for promoting national health as a part of student education. We how far-reaching are the impressions left on minds by a good teacher. For some of our most bri statesman, our most honored scientists, we may some elementary, high school or college teache inspired enthusiasm, gave encouragement, or o advice. Given the opportunity, the teaching profe may make an outstanding contribution to the imp ment of the nation's health by furthering nut education. ●

★ ★ ★ ★ ★

"The intensified division of labor has become a sp device for escaping social responsibilities. As p sions subdivide, each group of specialists finds creasingly possible to 'pass the buck' for the socia sequences of their work, on the assumption, it seem, that in this complex transfer of respons there will be no hindmost for the devil to take. appalled by resulting social dislocations, each spe secure in the knowledge that he has performed hi to the best of his ability, can readily disclaim res bility for them."

Robert Merton
Columbia Univ
Science
January 24, 19

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